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LI HUNG CHANG.

WHEN the Emperor of China selected the subject of this sketch to represent the great Oriental empire at the late coronation of the Czar of Russia, he chose the man who is pre-eminently qualified by his character, person, and achievements to stand as the representative of all that is noblest and best in the Chinese people. Born in comparatively humble circumstances, he was, and for that matter is yet, one of the people. His steady rise to the highest position in the empire has been entirely due to his sterling character and varied talents. That these qualities should bring their possessor into positions of trust and honor is to be expected among the civilized nations of the western world, but that they should have done so amid the corruption and treachery which infest the governments of Oriental nations is the very highest tribute to the qualities of a statesman like Li Hung Chang, whose years of distinguished public service are reckoned by the score, and whose fortunes, in spite of two dismissals from favor, find him to-day in greater honor and wealth than at any period of the long seventy-four years of his life.

It was peculiarly fitting that in making his great journey round the world, the circumstance of the Czar's coronation should have caused him to travel from east to west; for in so doing he has followed the march of that civilization which was cradled in the great empire which he calls his home. In Russia he was entertained by a people who are slowly throwing off the bonds of despotism, not so much by the struggle of the masses as by the enlightenment of the governing powers, and the growth, slow but sure, of broader views of the rights and liberty of the individual. In Germany and France he saw the fuller triumph of western civilization, hampered though it is by the burden of military taxation. In England he saw a people who had grown enormously in wealth and possessions by the exercise of those industrial arts which it has been one of the great efforts of his life to introduce into China; and now, during his stay in America, he will fitly close the many visits of his long journey of thirty thousand miles, among a people who represent the latest and highest developments of western progress. Li Hung Chang, who is now 74 years old, was born in the province of Anhui, on the north side of the River Yangtse Kiang, in the year 1822, in which year also was born General Grant, America's representative soldier, for whom the Chinese statesman had a profound admiration.

Li Hung Chang was of humble origin, went early to the common schools, and from them to the Hanlin College, where he displayed uncommon ability, and by virtue of his attainments found his way into the public service. The distinction which he gained at college gave promise of that ripe scholarship for which the Viceroy has been long and justly celebrated. The Taiping rebellion gave him the great opportunity of his life. It was a calamitous and long drawn out struggle, which was originated by a certain Hung Tse Chuen, "a disappointed scholar," who had dreams, saw visions, received "a call," promulgated a faith which was made up of a strange medley of the teachings of Confucius and Christ, and gathering round him a following, opened up a rebellion which was distinguished more than anything else by rapine and murder. The rebellion progressed rapidly, and the government was powerless to quell it. The first check was received at the hands of Li Hung Chang, who, on the approach of the rebels, gathered a volunteer army, drilled it, and attacking with great dash, threw them into disorder. He was at once called to the staff of the Emperor's army, and rose ultimately to be governor-general of a province and commander-in-chief of the field army. Early in the conflict a contingent of the Chinese army, composed of foreign residents of the seaboard, attracted attention by their success under the leadership of F. E. Ward, an American, who was later on succeeded by another American named Burgoyne, who in turn gave place to Lieut.-Col. Gordon, of the Royal Engineers. The admirable force of several thousand men was further increased and improved by Gordon, and it was his able co-operation with the imperial forces under Li Hung Chang that led to the ultimate suppression of the rebellion.

The experience of the fourteen years of this struggle not only served to develop the soldierly qualities of Li Hung Chang, but it served, through the foreign contingent of his army, to bring him into touch with western ideas, and to impress him with the necessity of adopting western weapons and tactics, if he would preserve his country from foreign aggression and domestic uprising. The rebellion was finally put down in 1865, and it was in 1870 that he was appointed as governor-general of the province of Pechihli, which contains 17,000,000 souls and includes Pekin, the capital, whose port of entry is Tientsin.

"In addition to the duty of providing for the safety of the Emperor and the court, the maintenance of the canal, and the safe transmission of the government taxes in kind, the governor-general of this province has also to care for the public defense, superintend the foreign and maritime trade, receive foreign and native officials, and transact in addition the multifarious duties of a provincial ruler, who, within his own jurisdiction, is an emperor in petto, but whose every act is scrutinized with suspicion, and is subject to be overruled by the throne, from which all authority is derived."

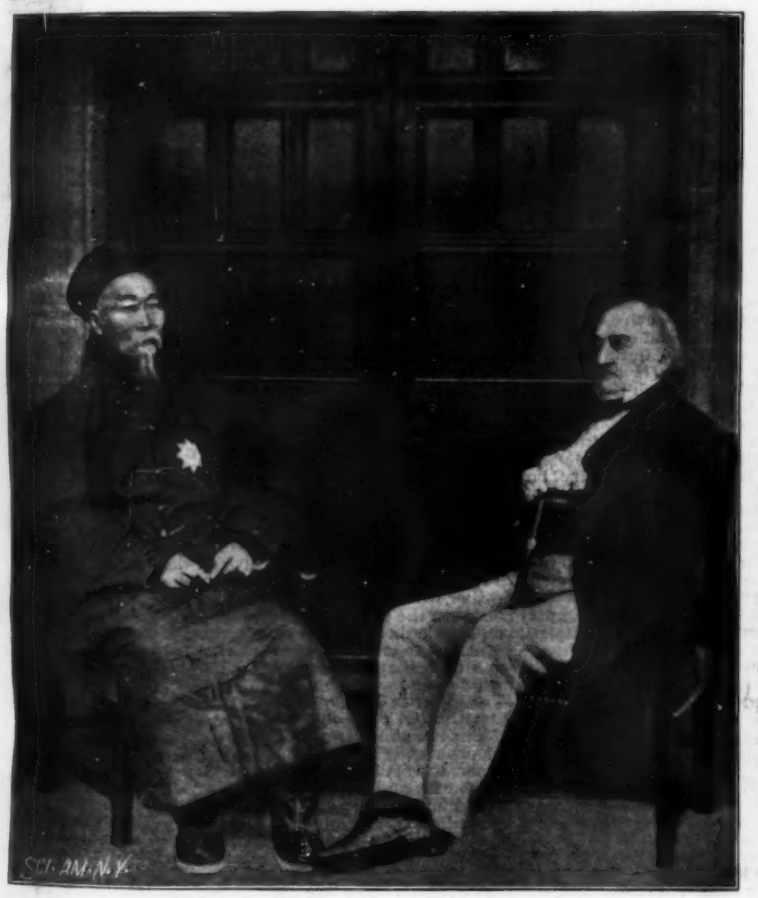
He was subsequently appointed by the Empress Regent to the post of Viceroy and First Grand Secretary of the Empire; vacated the office in 1883; but was recalled in the same year, and held the post continuously until the war with Japan.

It was at Tientsin that the Viceroy received General Grant, and the acquaintance then formed ripened into friendship, which has been extended to the surviving family of the deceased soldier. Some idea of his high estimate of Grant may be formed from a speech which he delivered at a banquet given in honor of the visitor, in which he said:

"General Grant's eminent talent as a soldier and a statesman, and his popularity while chief ruler of a great country are known to us all. I think it may be said of him now, as it was said of Washington a century ago, that he is first in war, first in peace, and first in the hearts of his countrymen. His fame and the admiration and respect it excites are not confined to his own country, as the events of his present tour around the world will prove."

The lasting nature of Li Hung Chang's regard for men of such sterling worth as General Grant and General Gordon is seen in the memorial tribute which he paid in person at the resting place of both soldiers, the one in London, the other in New York.

The disastrous war with Japan in 1894 would never have happened if the policy of the Viceroy had prevailed. He was always desirous of cultivating friendly relations with that country, and he was too well informed not to see the inevitable disaster which would happen when the well drilled and modern army and navy of Japan encountered the obsolete methods and equipment of the Chinese army, and her unprepared, though excellent navy, whose ships were wanting both in men and ammunition. What efficiency was to be found either in army, navy, or fortifications was entirely due to the unwearied efforts of the great statesman, and at the close of the war it was his diplomatic ability which succeeded in mitigating the severity of the terms of the treaty of peace.



LI HUNG CHANG AND THE HON. W. E. GLADSTONE, AT HAWARDEN.

LI HUNG CHANG AND LORD SALISBURY, AT HATFIELD HOUSE.

It is a matter of history how the Chinese troops were overthrown in the Korea and in Southern Manchuria, and the fleet destroyed at the battle of the Yalu. On receipt of the tidings of these disasters, Li Hung Chang was deprived of his honors and authority, including the famous yellow jacket, the highest distinction which can be conferred by the Emperor; though the blame should have rested entirely upon the system and not upon the man. But when the Japanese army, flushed with victory, was making preparations to march on Pekin, the capital, the government, in a panic of fear, placed the yellow jacket upon the shoulders of its able and faithful servant, his titles were restored and he was dispatched to Japan with full powers to negotiate for peace. He was received at Shimonoseki with all honor, but, unfortunately, upon landing, was shot in the face by a Japanese fanatic. To this day he carries the bullet lodged in his cheek bone, from which it was deemed inadvisable, on account of his great age, to extract it. The treaty of peace was drawn up by the Viceroy and Count Ito, the Japanese representative. On his return the aged ambassador was again degraded, on the ground that he (of all men in the world) had betrayed his country. But, when this year it was decided to send a worthy representative of China to the coronation of the Czar of Russia, there was but one man to be found who had the international reputation which would warrant his selection for the purpose, and this was Li Hung Chang. So his rank was restored to him, together with the title of earl and the office of ambassador, and placing again upon him the "yellow jacket"—the Chinese "order of the garter"—his country sent him forth on his long journey to the great nations of the western world.

It is impossible within the limits of this sketch to give any detailed account of the distinction with which this remarkable man was received in the European countries through which he passed. Suffice it to say that his reception has shown the high esteem in which he is deservedly held and the popular interest which his appearance invariably awakened. We have selected for illustration the occasion of his meeting with two of the foremost statesmen in England; one of them Lord Salisbury, the present Prime Minister of England, who is still engaged in the active service of his country; the other the Hon. W. E. Gladstone, who is enjoying a well earned rest after his long political life. The photographs of Li Hung Chang were taken at the country residences of his hosts and published in Black and White.

Apart from the fact that the Viceroy's journey was undertaken specifically with reference to the coronation of the Czar, the exact purpose of his visit to other countries has not been announced. In England it transpired that he was aiming to effect an increase in the Chinese tariff, and his references in this country to the Geary law regarding Chinese immigration show that his journey is undertaken with a view to judging by personal contact and observation of those international questions which affect the welfare of his own country. During his brief stay in France he met many of the leading government officials, including President Faure. In England he visited Lord Salisbury, the Prime Minister, at the Foreign Office, and the Queen at Osborne. He inspected the dockyards at Portsmouth and was present at a review of the fleet. He won the popular enthusiasm by his graceful tribute to the memory of General Gordon; and finally left for this country on the steamship St. Louis, of the American line. On his way up New York Harbor on Friday, August 28, he was received with a salute of twenty-one guns from the fleet of warships of the new navy, and was met by representatives of the government and of New York City on the Dolphin. An escort of United States cavalry accompanied him, amid great enthusiasm, to the Waldorf Hotel, where liberal provision had been made for the visitor and his suite. On the following day the Viceroy called on the President of the United States at the house of Mr. Whitney, where he read an address from which the following is an extract:

"It will always be the desire of my august master, the Emperor of China, to maintain the most cordial relations with America, whose friendly assistance rendered to the government of China, after the China-Japanese war, and whose protection for the safety of the Chinese immigrants in America are always to be highly appreciated.

"I am now especially appointed by my august master, the Emperor of China, to present to your Excellency the assurances of his most friendly feelings toward the United States of America in hope that your Excellency will reciprocate his sentiments and co-operate with him to promote the friendly intercourse between our two countries for the cause of human kind.

"I trust that your Excellency's government will continue to afford protection and kind treatment to the Chinese immigrants in America, and to render friendly assistance to the Chinese government when required.

"May the peoples of our two nations enjoy the benefits of perpetual peace."

The President, in reply, referred to the increasing friendliness of the feeling between the two countries and said: "Notwithstanding the widely different characteristics of the two countries, the welcome which is tendered you by the government and citizens of the United States illustrates in the strongest possible manner the kinship of nations. We feel that, in the arrangement of your tour, you have not allotted to your sojourn among us sufficient time to gain an adequate observation of all we have accomplished as a nation. It will not, however, escape your notice that a rich and fertile domain has here been quickly created by those who were assured that they would reap where they had sown; that a strong and beneficent government has been here established by those who loved freedom, and that we have a generous and patriotic people who love their government because it is theirs—constructed by them, administered for them and protected and saved from harm by them."

The Viceroy was subsequently visited by the mayor of New York City, and in the evening was entertained at a banquet by former American residents in China.

On the following day Li Hung Chang visited the tomb of his friend, General Grant, and placed upon it a memorial wreath, and during his subsequent call on Mrs. Grant he informed her that each year he has sent a wreath to the Chinese minister at Washington, who had laid it in the Grant vault.

On Monday the visitor was taken to West Point, and on the following day the programme opened with an address of congratulation from all foreign missionary boards, and was followed by a luncheon at the Merchants' Club, where the Viceroy's Chinese interpreter, on chancing to hear a city merchant speak of having rowed in a former Harvard University boat race, stated with a quiet smile that he himself was coxswain in the winning boat on that occasion. The interpreter was one of a set of Chinese students who were Harvard men in that particular year.

The reply of Li Hung Chang to the address of the missionary societies was remarkable for the comparison which he drew between the Confucius of the eastern and the Christ of the western world. It gives us a glimpse at the religious convictions of a scholarly follower of Confucius, which is so full of interest as to warrant its repetition.

"In a philosophical point of view, as far as I have been enabled to appreciate, Christianity does not differ much from Confucianism, as the Golden Rule is expressed in a positive form in one, while it is expressed in the negative form in the other. Logically speaking, whether these two forms of expressing the same truth cover exactly the same ground or not, I leave to the investigations of those who have more philosophical tastes. It is, at the present, enough to conclude that there exists not much difference between the wise sayings of the two greatest teachers, on the foundations of which the whole structure of the two systems of morality is built. As man is composed of soul, intellect and body, I highly appreciate that your eminent boards, in your arduous and much esteemed work in the field of China, have neglected none of the three.

"I need not say much about the first, being an unknowable mystery of which our greatest Confucius had only an active knowledge. As for intellect, you have started numerous educational establishments, which have served as the best means to enable our countrymen to acquire a fair knowledge of the modern arts and sciences of the West. As for the material part of our constitution, your societies have started hospitals and dispensaries to save not only the souls but also the bodies of our countrymen. I have also to add that at the time of famine in some of the provinces you have done your best to the greatest number of the sufferers to keep their bodies and souls together."

Perhaps the most interesting conversation of the Viceroy took place when he met the representatives of the New York newspapers at the Waldorf Hotel. He conversed with great freedom on a wide variety of subjects, and betrayed a wonderfully intimate knowledge of the United States, its government and its people. He spoke very emphatically, as was natural, of the Geary act and the exclusion of Chinese labor. The following is the verbatim interpretation of the Viceroy's replies to questions touching this matter:

"The Viceroy says the Chinese exclusion act is a most unfair one, because it is admitted by the political economists that the competition will always keep the market in good health, whether it is labor or commodities. Now, this act is influenced by the Democratic party, by the Irish party, by the laboring class party. They wish to monopolize the labor market, and, as the Chinese are their strong competitors, they exclude them. It is the same thing as if you bring a good many goods, commodities, to China, and can sell them cheaper than the European countries, and we exclude you from the market. Is that fair or not? The Viceroy says put aside that he is a high Chinese official or mandarin; suppose he is a cosmopolitan; he only will study the interests of America. Is that a policy or not, to exclude the cheaper labor from the market or to exclude the cheap commodity, to prefer to buy a commodity which is inferior in quality but superior in price? Is that a good policy for your domestic economy? The Viceroy says, you pride yourselves that your States represent the best type of modern civilization. You are proud of your liberty, you are proud of your freedom, but in this case there is no freedom of labor, of the labor market."

That the visit of Li Hung Chang will serve to strengthen the excellent relations between this country and China cannot be doubted; and it is certain that in our effort to increase the volume of trade between the two countries we shall have the active co-operation of the astute, observant, and farsighted statesman, who is winning esteem and adulation on every hand during his brief stay in our midst.

SILK MADE OUT OF WOOD.

THE London Times says: There will shortly be started in Lancashire a new industry of a character so novel that the mention of it may appear to be suggestive of an absurdity rather than of sober truth. It will be one for nothing less than the manufacture of silk out of wood pulp. Quixotic as the idea seems, it has already been established that silk, or rather, artificial silk, can be so made that it can be used for the many purposes for which natural silk is used, and others besides; that it is especially suitable for working up with natural silk, cotton, or wool for dress material, ribbons, trimmings, church decorations, vestments, etc.; that the artificial silk can scarcely be distinguished from that for which we have hitherto depended on the silkworm, and that it can be sold at prices very much lower and still leave a substantial profit.

Dress and other fabrics made from this wood silk are, indeed, already being sold extensively in London as among the leading features of this season's Paris novelties, though the appearance of them is so close to that of the ordinary silks, and so little has been said of the new discovery, that neither the ladies who have bought them nor the shopkeepers who have sold them have realized the change that has been brought about in the process of manufacture.

At present the wood silk comes from France, large works having been established at Besançon under patents granted to Count Hilaire de Chardonnet, Chevalier of the Legion of Honor, who discovered the process and first established in 1893 the fact that it might be made into a commercial success. Since then the demand for the new commodity has far surpassed the existing powers of manufacture, and some months ago the idea was mooted of adding to the number of our own industries by arranging to make the artificial silk in England as well. The project seemed to be especially desirable in the interests of Lancashire, whose commercial prosperity has been seriously threatened of late, while it was pointed out that Lancashire weavers are much more skilful than the French in working up those textile combinations for which the artificial silk is particularly, though not exclusively, adapted.

A number of silk and cotton manufacturers met to discuss the question, and finally sent out to Besançon a deputation consisting of some of their own number, an engineer, a chemist, and a lawyer, to investigate the subject thoroughly. This was done, and the outlook was found to be so promising that certain concessions have been secured; and a company is now in process of formation, and, to begin with, a factory, which will cost £30,000, is to be built near Manchester for the manufacture of artificial silk yarn from wood pulp, for sale to weavers, who will work it up by means of their existing machinery. Inasmuch as six weaving firms have already arranged to take the total output of the factory, even before a single brick has been laid, and as others are proposing to put down plants of their own to be worked on the royalty system, there is evidently good reason for the expectation that Lancashire is on the eve of some important expansions in her textile trades.

The prospects are the more satisfactory because the concessions which have been secured specially stipulate that Continental makers of the artificial silk are not to send their yarn to England, while the international patent laws will, now that the rights for Great Britain have been bought up, secure that henceforth neither the yarn nor the goods manufactured therefrom shall be imported here. Thus, although the original idea comes from France, the industry, so far as this country is concerned, will be essentially British, and will be carried on without fear of foreign competition.

At the present time our imports of articles manufactured from silk are so extensive that last year they amounted to £15,237,000, and those of raw and thrown silk to £1,883,000, or a total of £17,120,000; but now that industrial ingenuity has shown that the silkworm can be supplanted by any sort of timber, there is thought to be a good prospect of distributing a good deal of the money among our own workers instead of abroad.

The way in which wood pulp can be converted into silk yarn will be best explained by a brief account of the process as it is already at work at Besançon. A certain economy of labor is practiced by obtaining the wood when it is in its "paper" or "cardboard" condition (though waste cotton may also be used), and the first operation is to macerate it in a solution of nitric and sulphuric acid. After this the acids are squeezed out by a hydraulic press, and the stuff is thoroughly cleansed in large vats of water. It is then partially dried, and afterward left for some hours in a revolving cylinder containing alcohol and ether.

After this it is passed through a filter, which it leaves looking very much like thick gum, and is next put into cylinders, from which it is forced by pneumatic pressure into pipes passing into the spinning department. Here the machinery looks like that employed in Lancashire spinning sheds, except that one of the pipes referred to runs along each set of machines. These pipes are supplied with small taps, fixed close together, and each tap has a glass tube, about the size of a gas burner, at the extreme point of which is an aperture so minute that the filaments passing through no fewer than ten of them would be required to make up the thickness of a human hair. These glass tubes are known as "glass silkworms," and some 12,000 of them are in use in the factory.

The effect of the pneumatic pressure in the cylinders referred to above is to force the liquid matter not only along the iron tubes, but also, when the small taps are turned on, through each of the glass silkworms. It appears there as a scarcely perceptible globule. This a girl touches with her thumb, to which it adheres, and she draws out an almost invisible filament, which she passes through the guides and onto the bobbin. Then, one by one, she takes eight, ten, or twelve other such filaments, according to the thickness of the thread to be made, and passes them through the same guides and onto the same bobbin. This done, she presses them together with her thumb and forefinger at a certain point between the glass silkworms and the guides. Not only do they adhere, but thenceforward the filaments will continue to meet and ahere at that point, however long the machinery may be kept running. In this way the whole frame will soon be set at work, the threads not breaking until the bobbin is full, when they break automatically, while they are all of a uniform thickness.

The remaining processes are the same as in the case of ordinary silk, except in two respects. In the first place, the artificial silk has to be denitrified, so as to render it non-inflammable after the chemical processes it has undergone; and in the next place, the hanks are placed on two revolving rollers, which stretch and also "iron" them, producing that high degree of luster which is one of the chief characteristics of the artificial silk. The new product is said to take dye much more readily than the natural silk, and certainly the colors and the extreme richness of some specimens that have been on view in London seemed to leave nothing to be desired in this respect.

The chief difference in appearance between the natural and the artificial silk is in the greater luster of the latter; though it will be found also that if a single thread of each is taken the artificial will "break" differently from the natural, and has only about 80 per cent. of its strength.

The success already secured by the new process in France is such that the introduction of the industry into Lancashire is expected to produce something like a revolution in the conditions of trade there, not only by bringing into existence a new occupation, but also by finding more work for a good deal of the weaving machinery that is now only partially employed, while the weaving of "silk," or what only experts will be able to distinguish from silk, will be rendered possible in the case of a vast number of people to whom the product of the silkworm is more or less a prohibitive luxury.

All the same, there will probably be some sentimental regret that the silkworm itself, which has played so important a part in the clothing of the peoples of the western world since the middle of the sixth century, should thus run the danger of being supplanted by liquefied timber, though the discovery that clothing can be made out of wood pulp is, after all, no more remarkable than that which was made by the Persian missionaries who visited China 1,300 years ago and learned, to their surprise, that garments could be made from the cocoons of a caterpillar.

[Continued from SUPPLEMENT, No. 1079, page 17242.]

THE EMBLEMATIC USE OF THE TREE IN THE DAKOTAN GROUP.*

By ALICE C. FLETCHER.

IN the clan organization, the totem came to be representative pre-eminently of kinship; and its sign, as we have noted, was placed upon the dead, that they might be recognized by their kindred in the other world and led directly to their clan. The function of the totem was social, rather than individual; the Indian depended for his personal supernatural health upon his own special vision, and his clan totem in no way interfered with his entrance into any religious society.

The resemblance which exists between the rites and rituals of the religious societies and those which hedge about the office of Chief, and Soldier, and Herald marks the influence the societies have exercised upon the development of the tribal structure.

The control of the Thunder people runs like a thread through all the tribes of the Siouan group. The character of their vision was such as easily to win popular recognition as pre-eminently authoritative, and they seem to have been singularly dominant from the earliest time.†

The Thunder gentes had charge of, or took an important part in, all ceremonies which pertained to the preservation of tribal autonomy. To them belonged the rituals and ceremonies which inducted the child into its rights within the gens and the tribe; the adoption of captives and strangers; and the ceremonial preparation of the tribal pipes, without which there could be no tribal ceremony or enforcement of order. They had charge also of the rites for the preservation of crops from the devastation of insects and marauders. These were some of the exclusive functions of the Thunder gentes; but the rites of the worship of Thunder itself, and the ceremonies pertaining to war, of which Thunder was the god, so to speak, were in charge of other than the Thunder gentes.

In the Omaha tribe the Sacred Tent of War was set apart for the rites and ceremonies connected with Thunder. It was pitched in front of the segment of the tribal circle occupied by the We-jin-shte gens, its Keeper. It stood apart as a special lodge, and was regarded with awe by the people. In it were kept the Sacred Shell (a large Unio alatus); the Wa-in (a bird-shaped bundle made of raw hide, containing the skins of certain birds believed to be associated with Thunder); the Pipes used in the ceremonies of war; and a Pole of cedar.

In the myths, the cedar tree is spoken of as the particular abode of the Thunder Birds. The Thunder Beings had their village amid a forest of cedars, and the club of these mythical beings was of the same tree. Cedar leaves were put upon the War Pipe after it was filled, so that when it was lighted, it was the aromatic smoke of the cedar that was offered to the Four Directions, the Zenith, and the Nadir. The cedar Pole, representative of Thunder, was called Wa-ghdhe-ghe, which means the power to confer honors. This name refers to the custom which prescribed that all war parties should start from this Sacred Tent and on their return report to it; and that all honors, namely, the right to wear certain regalia indicative of a man's prowess in battle, should be ceremonially conferred in this Tent.‡

The vital point, in the ceremony of conferring honors, was when the warrior, standing before the Wa-in, and reciting his deeds of battle, at a sign from the Keeper, dropped a small stick upon the bundle. If the stick rested thereon, it was believed to be held by the Birds, who thus attested to the truth of the warrior's claims. If it rolled off upon the ground, it was the Birds who discarded it, because the man had spoken falsely. These Birds, representative of Thunder, were the judges of a man's truthfulness, and rewarded him by honors, or punished him by disaster, even to the tearing out of his tongue by a lightning stroke.

Naturally, in course of time, those warrior chiefs who by favor of Thunder had been successful in war, whose truthfulness had been attested by the Thunder Birds, and who had received their regalia, began to assume for themselves some of the authority conceded by all to Thunder itself. A song belonging to a Dakota chief says, "When I speak, it is Thunder." Gradually the exercise of the punishing power was extended to social offenses; as, for instance, a man whose persistent evil conduct threatened the internal peace of the gens or tribe, might suffer loss of property or even of life, his fate being determined by the warrior chiefs assembled at the Sacred Tent around the cedar Pole, the representative of the Thunder; the function of the chiefs thus becoming augmented by affiliation with the supernatural.

When the first Thunder was heard in the spring, the ceremonial of the worship of Thunder took place at the Sacred Tent. The Wa-in was opened and the bird skins exposed; the Pipes were smoked, the ritual sung, and the cedar Pole anointed. No one participated in these rites, except the members of those gentes whose totems were believed to be related to Thunder. Some of these totems were of creatures predatory in their habits, and therefore allied to the destructive lightning; others, like the eagle and the hawk, could soar to the very clouds, while the flying swallows heralded the approaching storm. This fancied kinship of their totems was the basis of recognition of a sort of relationship between the gentes themselves, which became the ground upon which these people united in the performance of ceremonies directed toward a common object of worship.

Although important steps had been gained in social development, none of the rites and ceremonies of the Sacred Tent of War tended to bind all the gentes together, but the Omaha ceremony of the He-di-wa-chi seems to have been adapted to meet this requirement. It is impossible to state as a fact that the He-di-wa-chi grew out of the experience of the people during the centuries when they were being slowly driven by wars farther and farther from their eastern home; but, according to traditions preserved in the different tribes, it was during this period that group after group parted company, and the enfeebled bands became a tempting prey to active enemies. Nor was the danger always from without; disintegration sometimes resulted from the rivalry of ambitious leaders, and, to quote from the tradition, "the wise men thought how they might devise some plan, by which all might live and move together and there be no danger of quarrels."

Many points in its ceremonial indicate that at the time of the institution of the He-di-wa-chi the people had entered upon agricultural pursuits and were not wholly dominated by those ideas which had been the controlling power when hunting and war were the principal avocations. The He-di-wa-chi took place in the summer solstice, or, according to Indian designation, at "the time when all the creatures were awake and out." The choice of the tree from which the Pole, the central object in this ceremony, was to be cut, is significant. It was either the cottonwood or the willow, both remarkably tenacious of life, sending forth shoots even when cut down and hacked into posts. In the Indian's words describing the time when this ceremony was to take place, we catch a glimpse of a shadowy idea of peace, for when danger stalked abroad the animals which were "awake" would not be "out" but in hiding; and in the choice of the tree with its abounding life, we note the beginning of an apprehension of the idea of the conservation of life. This helps us to open out and understand the terse and poetic expression of the Indian tradition concerning this ceremony, that "it grew up with the corn." The ideas embodied in this festival found their birth and growth in the cultivation of the maize, which held the people to their fields; preventing their constant wandering after the wild animals, and so inaugurating village life, and developing an appreciation of tribal unity.

The first act in the preparation of this ceremony was the cutting, by the Leader having it in charge, of seven cottonwood or willow sticks which were stripped of leaves with the exception of a small spray at the end, thus making a miniature pole. These were sent to the chiefs of the seven original gentes, who in their turn sent out the men of their gentes to cut similar sticks, which were to be painted red and carried in the great tribal dance about the Pole.

While this was being done, the Leader selected runners to represent warriors, who were to go out as a scouting party would go in search of an enemy, and when they found the tree which was to be cut for the Pole, they were to charge upon it and strike it as they would strike a foe. In this ceremony of selection where war is so simulated, the recognition of the power and authority of Thunder is manifest, for no man could become a warrior except through his consecration to Thunder, the god of war. Moreover, it was believed that no man could fall in battle through human agency alone; he fell because Thunder had designated him to fall. So the tree, which had been struck as a foe, fell because Thunder had selected it. The tree thus chosen was now approached by the Leader who said, "I have come for you that you may see the people, who are beautiful to behold." Then with elaborate ceremonies, in which the Four Directions were recognized, the tree was cut down; the bark and branches, all but a tuft at the top, were removed and buried at the foot of the stump, and the Pole, with much ceremony, was carried to the camp, where it was painted by the Leader in alternate bands of red and black, symbolic of Life and of Thunder. When this was done the Leader said, "It is finished, raise him up that your Grandfather (i. e., Thunder) may see him."* The Pole then, being placed in position in a hole prepared for it, stood before the people as approved by the ancient Thunder Beings. Then the Herald went forth to call the people to make ready to welcome the Pole with dancing and gifts.

Now the camp is astir with preparation; every one dons his gala dress and hastens to take his place with his gens in the tribal order, forming an immense circle around the Pole. The singers, seated at the foot of the Pole, strike up the first of the ritual songs; at its close the war cry is given by all the people, who then advance a short distance and halt. Four times the song is sung, four times the cry is given, four times the people advance and halt, and at the last pause they are near the Pole. At this point the men of the In-ke-tha-ba gens, led by two pipe bearers, face about to the west, their right side to the Pole, and the women face to the east, with their left to the Pole. Each of the other gentes falls into like order behind the In-ke-tha-ba men and women, and when the second ritual song is begun the entire double circle begins to dance around the Pole. During the dance four halts are made, and at these halts if any dancer has passed beyond the line of his gens, he must return to it. The songs become more and more rapid in measure, and the dance fuller of mirth and gayety. At the close of the ceremony the men, women and children throw their sticks at the foot of the Pole, to which they are tied and left for the sun and wind to dispose of.

The manner in which the Pole was approached by the whole people in the order of the tribal circle, with war cry and charge, was a recognition of the victories gained through the war god Thunder. The entire ceremony was a dramatic teaching to old and young of the necessity of union not only for defense, but for the preservation of internal peace and order, in the security of which industry might thrive and prosperity be within the reach of all.

The He-di-wa-chi, all the details of which cannot here be described, is a festival of joy; the words of the opening song are, "Come and rejoice!" The whole scene vibrates with color and motion; there is no hint of sacrifice, the Thunder-selected tree is a symbol of Life, held in the fruitful grasp of the earth, and touched by the beneficent rays of the sun.

The so-called Sun Dance of the Dakotas and Ponkas seems to have sprung from the same parent stem that bore the He-di-wa-chi; but it shows marks of the influence of tribal environment during the past few centuries, as well as traces of contact with other stocks. For a considerable period prior to our first knowledge of the Dakotas, these tribes had dwelt in the most northern range of the Siouan linguistic stock, and had almost lost their knowledge of the cultivation of corn. Omaha traditions say that their own tribe turned back from the region where the Dakotas were when first discovered by us, because corn would not grow well there, and they sought sites for their villages farther south, where they could raise the maize in large and unfailing crops.

The Sun Dance and the He-di-wa-chi have fundamental features in common. They take place at the same time of the year; both Poles are cut from the cottonwood or willow tree; the ceremonies attending the cutting and planting and decorating the Poles are practically the same, differing only in the elaboration of detail. Both are consecrated by and to Thunder, and about both the tribe must gather in the order of the gentes. The special rites of the Sun Dance are performed within a communal tabernacle erected about the pole. It is made of one or more poles gathered from the tent of each family in the tribe, and covered with green branches. It represents the living branches of the tree, as well as the great congregation of the people, whose tents inclose it in a circle often more than a mile in circumference.

The elaborate character of this ceremony precludes the mention of any of its parts, except those which pertain to the subject of this paper.

The symbol placed upon the buffalo skull, and drawn upon the U-ma-ni—a space of ground from which the sod had been removed, and the earth made fine—is a circle with four projecting points equidistant from each other. This symbol, to quote from Dakota Indians who had been instructed in this ceremony, "represents the tribe and the Four Directions. It means that, wherever the tribe may travel, it will be kept whole. Its circle of tents will not be broken, the members of the tribe shall live long and increase. The symbol also stands for the earth, and the unseen winds that come from the Four Directions, and cross over the earth and bring health and strength." The people were told, that, "as long as they observed the ceremony, they would increase and grow strong, but if they should neglect the rite, they would decrease in numbers, lose their strength, and be overpowered by their enemies."

The dramatic character of the adjuncts of self-sacrifice and torture has diverted the attention of observers from the true purpose of the Sun Dance, which has been clouded in the minds of the people themselves, but has not been lost sight of by the Indian priests, who still insist that the ceremony is necessary to the preservation of the people as a tribe.

The torture practiced at the Pole seems to be a transference to this ceremony of the ancient rite known as Hanm-de-pi, where the man suspends himself, while seeking a vision through fasting; or when, fixing his mind upon a particular desire, he expects through torture to render its accomplishment certain. Even in the Hanm-de-pi, there are indications of foreign influence which tended not only to keep alive, but to intensify the more primitive forms connected with Thunder worship—forms which had almost died out in the more southern tribes, surviving only in certain modified rites observed in mourning for the dead, and the leading of a war party.

In the absence of agricultural avocations and their attendant corn ceremonies, the belief that the Pole was selected and consecrated by Thunder came to be more and more pronounced, as is indicated by the fact that the Thunder men only could take charge of the Sun Dance, whereas, in the He-di-wa-chi it was the red corn people who were the Keepers of the ritual and Leaders of the ceremony. It is easy to see how, through the influence of Thunder, originally represented in the consecration of the Pole, and augmented by the dominance of the Thunder men, the torture rights came to be grafted upon a ceremony which, owing to environment, had lost something of its early significance.

When witnessing the Sun Dance, its composite character was impressed upon me, and the lack of unity between the parts was evident. Further study has shown how different rites have been united, and what are some of the influences which have brought about this grouping.

The Dah-pi-ke or Nah-pi-ke of the Hidatsas resembles the Sun Dance. It takes place at the same season of the year. The Cottonwood Pole is selected and cut with similar ceremonies; about it the communal tabernacle of willow boughs is erected, and all the people must gather to the rites. Like the Sun Dance, it bears evidence of the same influences, which have overlaid a tribal ceremony "that grew up with the corn," with those other rites wherein self-torture was practiced.

As in the He-di-wa-chi, the tree or Pole of the Sun Dance, and of the Dah-pi-ke, is left at the close of the ceremony to the destruction of the elements, or powers, to which, in the mind of the people, it belonged.

In the Sacred Pole of the Omaha tribe we have another offshoot from the same parent stem. In its rites, however, the fundamental ideas embodied in the ceremonies already considered have been still further developed and specialized. The selection of the Pole, its cutting, decoration, etc., the season when its ceremonies took place, and the compulsory attendance of the people, were all practically the same, as in the He-di-wa-chi, the Sun Dance, and the Dah-pi-ke.

In a paper read before this section last year the Sacred Pole was described. Your attention at this time will be called only to its peculiar function in reference to the tribal autonomy.

A tradition in the tribe says: "At one time the seven original bands wandered about independent of each other; each band had a pipe and a leader. The Hunga gens thought that if this continued there would be feuds between the bands. . . . So the Sacred Pole was made, around which the different bands might gather. The seven chiefs were called together, and they all united and have been so ever since." The Legend corroborates the tradition, for it says: "The ceremonies of the Sacred Pole were devised to hold the people together."

The institution of the Sacred Pole marked a political change in the tribe, from the government by hereditary chieftains to an oligarchy of seven chiefs who attained their position by personal ability to perform certain deeds, called Wa-dhin-e-dhe. The name of the old cedar Pole of the Sacred Tent of War, Wa-ghdhe-ghe, which, as we have seen, meant "the power to bestow honors," was given to the new Sacred Pole, which became the fount of honors won in peace, for the Wa-dhin-e-dhe were not deeds of war; for their achieve-

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* Paper read before the Section of Anthropology, American Association for the Advancement of Science, at the Buffalo meeting, August, 1896.

† The members of the Thunder society claim that, at death, they join the Thunder Beings, although they do not thereby lose their kinship rights in their clan in the other world, but an Indian born into a Thunder gens could not at his death join the Thunder Beings, unless they had appeared to him in his vision. The people believed that the voices of noted Thunder men who were dead could be heard in the mutterings of the approaching storm.

‡ All these regalia, which are graded in rank, refer to Thunder. In several of the tribes these are feathers of certain birds, worn in a particular manner; the peculiar painting of a man's face, body or weapons; and, as among the Osages, the tattooing of the body and arms with lines so drawn that, when the highest rank is attained, the tattooed figure will represent the Thunder bird in outline.

* These words, in the original, are of the nature of an invocation and consecration.

ment, industry and accumulation of property, as well as valor, were required. So also, whereas the honors, bestowed in the Sacred Tent of War, were worn by the warrior himself, or tattooed upon his own body, the ghdhe-ghe, or mark of honor authorized by the power represented in the Sacred Pole, was placed upon the daughter of the successful aspirant, the woman being the industrial factor in the tribe. The mark of honor consisted of two symbols: upon the forehead of the girl was tattooed a small round spot representing the sun, and upon her chest and back, a circle with four equidistant points; the same symbol that was made upon the earth and the buffalo skull in the Sun Dance, and bearing the same idea, of strength in unity.

The seven chiefs who formed the obligarchy must act as one man, for without unanimity in their councils nothing could be done. In their decisions all the seven men must be alike represented, and the resultant unity was believed to be derived from Wa-kan-da, present in and acting through the mysterious Sacred Pole. To quote from the Legend: "The chiefs are slow to speak, . . . no word is without meaning, and every word is uttered in soberness, . . . believing the words come from Wa-kan-da, so the words of a chief are few. They (the seven chiefs) have all one heart and one mouth. . . . After a question is decided, the Herald proclaims it about the camp circle, . . . none of the people dare dispute it, for they say, It is the word of our Chiefs."

The two avocations upon which the life of the people depended were agriculture and hunting, and these were controlled by the ceremonies of the Sacred Pole. From the pole was decided the time for planting the corn, and about it the ritual of the maize was sung. The great tribal hunt was under its immediate direction, the rules and regulations of which were an important part of its function. On this annual hunt, the people left their village and their fields in the care of a small guard and followed the herds, under the strict control of the Chiefs and of a body of men called Soldiers. During the entire time, two months or more, the rights and inclinations of the individual were held rigidly subordinate to the good of the tribe. The Sacred Pole was carried in advance of the people, as they moved from camp to camp. From its presence the runners went forth in search of the buffalo, and to it they reported upon their return. At the close of the hunt, the ceremony of thanksgiving and anointing the Pole took place, when the entire tribe gathered about this central object, erecting a communal tent for some of the particular ceremonies and offering gifts. Finally, the men enacted before it the events of their career, thus presenting a sort of dramatic current history of the tribe.

At the inauguration of the Pole and its ceremonies, to quote from the Legend: "The Leader said, this (the Pole) belongs to all the people, but it shall be in the keeping of one family." For over two centuries this Sacred Pole was preserved, and its tent was pitched a short distance in front of the segment of the tribal circle occupied by a subdivision of the Hun-ga gens, its Keepers. It was regarded with fear and reverence, as the supernatural protector of the people, as the power that assured to them an abundant supply of food, and commanded the co-ordination of the gentes and the unification of the authority of the Chiefs.

In all these rapidly considered ceremonies, marking periods in social development of this group of tribes—development more or less modified by shifting environments—we note the constructive force of the religious ideas of the people: ideas which, represented by the word Wa-kan-da and its kindred terms, imply the existence of an ever active, mysterious power, permeating all nature, including mankind, with the same life, thus making all things related and anthropomorphic. We have seen how these generalizing ideas become concrete, through the medium of the vision, and capable of exercising a practical, formative influence. We have traced this practical, formative influence in the unifying power of the totem, which welds together an extended though partial kinship within the clan or gens. We have seen it also operative in the religious societies, where an indestructible bond holds the members together, upon a basis other than that of blood relationship. The same influence has been found at work in the association of certain clans for a common worship, the tie of their association being a supposed relationship of their separate totems to Thunder, the object of their worship. We note also that the authority of Thunder was still further extended to embrace the entire tribe, inasmuch as every man was brought under its control through the rites and ceremonies connected with war. Furthermore, we discern that out of the ancient ceremonies connected with Thunder, wherein primarily the cedar tree was the mythical abode of the mystical Thunder Beings, and later, the cedar Pole stood as emblematic of their power and authority, were evolved the ceremonies that made use of the old symbols, but clothed them with ideas born of newer conditions.

In the He-di-wa-chi has been found preserved the outline of one of the simplest and probably oldest ceremonies instituted to draw the people together and unite them into an organized body. And it is apparent that the Sun Dance, the Dah-pi-ke, and the Omaha Sacred Pole, from the same root, kept the same fundamental aim in view, performing their ceremonies about the same central object, the tree or Pole, selected and consecrated by the all-powerful Thunder, recognized as the judge and rewarder of all the people. We have seen the chiefs summoned to the He-di-wa-chi by a tree stick, sent from the Keeper of the ceremony, each Chief in turn sending forth the men of his gens to gather each man's sticks for himself and family, and all the people assembled and dancing about the Pole by gentes, each one carrying his stick, which at the end of the ceremony was given back to the Pole. A simple object lesson: to teach that the tribe was, like the tree, animated by the supernatural mysterious power; and that the Chiefs were its strong limbs, upon which the smaller branches grew.

In the Sacred Pole ceremonies, the constructive idea was still further developed, until not only unity of gentes was required, but unity of authority among the Chiefs was enforced. This unity, whether as demanded in the enunciations of the chiefs, or, as necessary to the formation of the tribe, to the instituting of the religious societies, or to the development of the clan, depended upon the conception of Wa-kan-da, as manifested in concrete form through the medium of the Vision. The ancient thinkers among the Siouan people, in the long centuries of an unknown past, came gradually to realize the helpfulness and power that lay in social unity. Out of this realization these ceremonies were slowly evolved, wherein the Pole, bearing the topmost branches of the living tree, stood in the midst of the assembled people, as an emblem of the presence and authority of Thunder, the universally accepted manifestation of Wa-kan-da, and also, in its life and growth, as typical of tribal unity and strength.

THE OLDEST CIVILIZED MEN.

By E. D. COPE.

RECENT explorations in Babylonia have given us much information as to the characters and customs of the oldest civilized people of whom we have any knowledge. The earlier explorations were conducted by M. De Sarzec, French consul at Bagdad, and the report of his work was issued in a magnificent folio in joint authorship with the distinguished anthropologist of Paris, M. Leon Heuzey, beginning in 1889. A little later the department of Archeology and Paleontology of the University of Pennsylvania sent out Messrs. J. P. Peters and J. H. Haynes to make excavations further south in the Euphrates plain. They selected Nippur or Nufar as the point of research, and work has been continued there from 1888 to the present year. The climate of this place is very trying, and the character of the people dangerous, but Mr. Haynes, on whom much of the actual labor fell, obtained an amount of material which in quantity and quality equals that obtained by the museums of London and Paris.

SUMERIAN TABLETS FROM NIPPUR. (FROM HILPRECHT.)

The Philadelphia material has been investigated by Dr. Herman Hilprecht, professor of Assyrian and comparative Semitic philology in the University of Pennsylvania, and he has published two memoirs of great interest in the Transactions of the American Philosophical Society, the second of which was issued in the present year. From this memoir and the previous one of De Sarzec and Heuzey I compile a few facts regarding the physical characters and habits of the earliest inhabitants of Chaldea, the Sumerians or Accadians. The information on these points is obtained largely from statues and picture carvings on tablets of a dark limestone, found by De Sarzec at Tel-lo, and by Haynes at Nippur. The figures of animals of known species are so characteristic as to prove that the artists possessed a true eye for form. We may infer that their delineations of man are equally accurate, and that the conspicuous characters which they exhibit are trustworthy delineations. The general resemblance between the features depicted show that we have to do with an interesting and peculiar race.

In the numbers of The American Naturalist for January and February, 1893, Mrs. A. Bodington gave our readers a sketch of the Sumerian question. She followed the belief which had gained currency at one time, that these people were of Mongolian origin. Others have suggested that they were African. The drawings and statues described by Heuzey and Hilprecht show that these ideas were quite unfounded. I reproduce one of the latter from Hilprecht, which is known as the stele of Ur-Inlil. Ur-Inlil was the high priest (or padesi) of Nippur, and he is represented as making an offering to some god on the upper half of the drawing. On the lower half a goat and a sheep are followed by two men, one of whom carries a vessel on his head, the other carries a stick (see illustration). Another tablet from Nippur displays the same kind of men, and they are also represented on eleven tablets figured by De Sarzec and Heuzey from Tel-lo.

That these represent a race advanced in civilization is clear. They built temples and palaces on huge plateaus constructed of brick. They carved statues and vessels and made pottery. Especially they left records of their history on numerous cylinders and tablets of clay of which many have been preserved. They formed organized armies armed with spears, bows, and shields. What relation did these people bear to the people of Nineveh whose monuments were revealed to Europe by the labors of Rawlinson, thirty-five years ago? Heuzey declares them to have been older than the Assyrians, and this position is proved by Hilprecht, who believes their earliest king whose name is preserved in the records of Nippur, Enshagsagana, to have lived 4500 B. C. Many kings intervened between him and Sargon I with whom Assyrian history for a long time commenced. These people were predecessors of the Assyrians of Nineveh, and gave them their cuneiform characters, but they differed from them in customs, and to some extent in language. One marked difference of custom was the fashion of shaving the hair from all parts of the head excepting the eyebrows. Everyone knows on the contrary that the Ninevites took great pride in their hair, and that both on the calvarium and face it was curled and arranged with great care. The figures also show that the Sumerians did not practice circumcision as most Semitic and some other races have done.

The shaving enables us to get a pretty good idea of the form of the head and face. The skull is oval, rather long and flat, and probably mesaticephalic. The jaws, both upper and lower, are remarkably small, giving an extreme orthognathic type. The nose is remarkably long, prominent and curved, with a good bridge. The

eyes are large, horizontal, and not bridled. The cheek-bones are not large, and in the supposed gods, where the hair remains, and in a few other unshaved portraits, the beard is abundant, and the ends of the hair of the calvarium curled up. The figure of the body is robust, broad and rather short. The extensor muscles, i. e., gluteus, quadriceps, and gastrocnemius, are well developed.

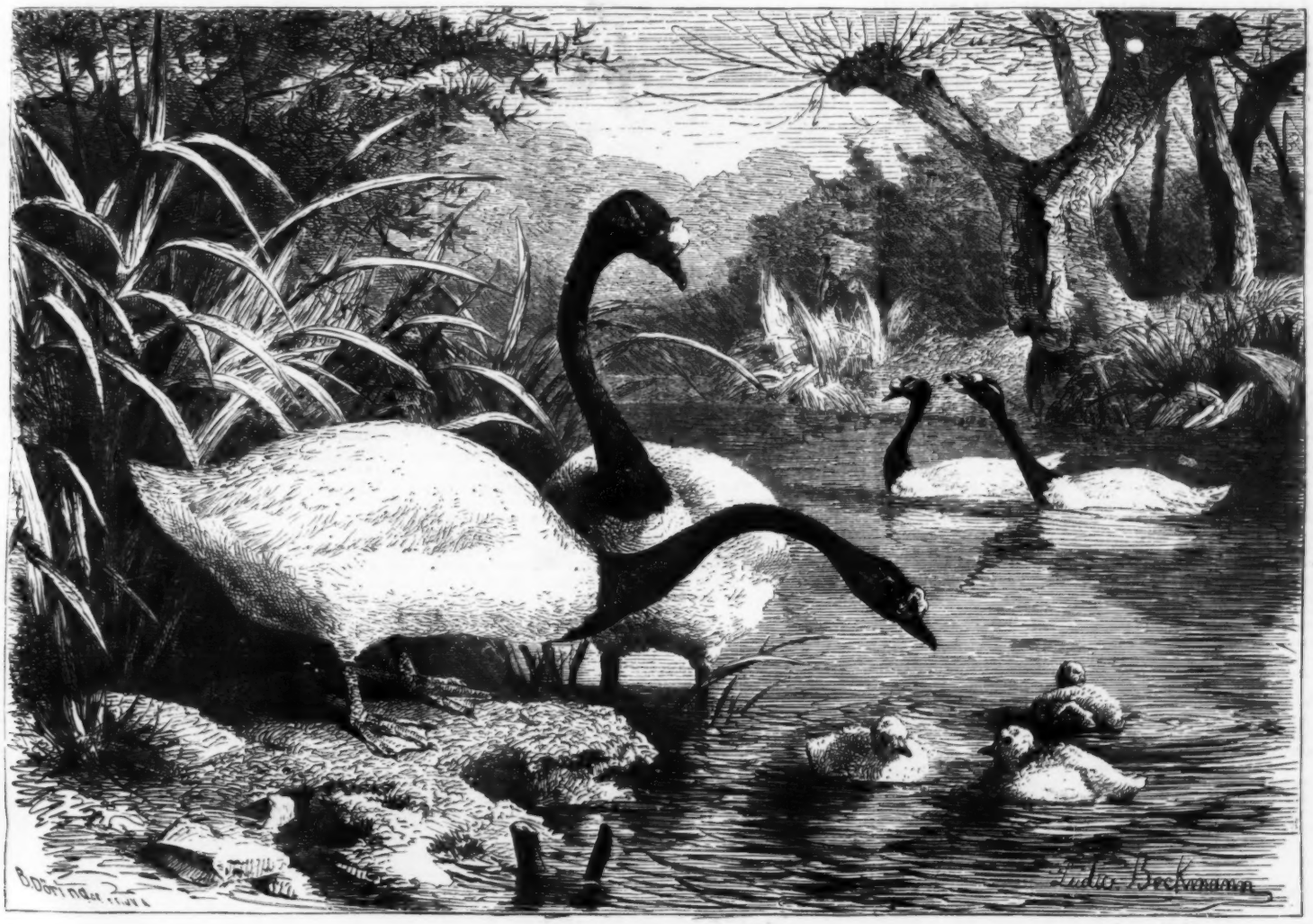
From the above it is evident that no thought of Mongolian (=Turanian) or Ethiopian relationship can be admitted. After a study of some of the least characteristic heads broken from statues, M. Heuzey remarks, that "the evidence is not sufficient to demonstrate the existence of Turanians in Chaldea." These people are clearly of the great Indoeuropean subspecies of man (Homo sapiens caucasicus), so that the question reduces itself to one of the determination of their race position. Are they Aryans or Semities? using these two terms as covering all the forms of the greater subspecies to which they belong. In the determination of these minor divisions of man, physical characters begin to fail us. We can only say that if the term Aryan is used for the western peoples generally, the Sumerians differ from them in the direction of the Semitics by their large oval eyes and hooked noses. On the other hand, the small and delicate jaws are not features of Semitic peoples. But the people of Persia, or Iranians, hold very much this intermediate position between the two peoples. We scarcely know the shape of the jaws and chins of the Ninevites, for they are never shaved. So far as the visible features go, they resemble the Sumerians. It is on all grounds to be supposed that the people of Nippur and Tel-lo are the primitive Aryans of the Iranian or Persian race, and ancestors of the Ninevites.

In any case it is evident that we have in these most ancient of civilized people a type of man as high as any that has since appeared from the point of view of physical evolution. The extreme orthognathism; the prominence of the nose; the reduction of the cheek bones; the full beard; and the well developed extensor muscles of the leg, prove this. Homo sapiens caucasicus had reached his full characters on the plains of the Euphrates 6,400 years ago.

The relation of time and race of the oldest civilizations to the prehistoric peoples is a problem which will doubtless be solved in time. Did the Neolithic people exist in Europe contemporaneously with the Sumerians of Chaldea? The only light that can be thrown on the question is as follows: The Sumerians were not stone people, but bronze people. They had no knowledge of iron. No search has been made for the remains of animals which were their contemporaries, but several species are clearly represented on their sculptures. The most common are the lion and the ox (Bos taurus, not the buffalo). There is a good drawing of a gazelle in the collection of the University of Pennsylvania. The goat and sheep represented on the accompanying illustration are species now existing in Persia. The goat is near the Capra ægagrus of the mountains of East Persia, the ancestor of the domestic goat; and the sheep is apparently the wild sheep of the same region, Ovis vignei. So from a paleontological point of view, the Sumerians were quite modern.—The American Naturalist.

THE BLACK NECKED SWAN.

ENGLAND possesses no more historical bird than the swan. Its place in heraldry is assured. Some of the old-time customs of marking swans on the Thames are still kept up with that love of custom of olden times so characteristic of the English race. In the reign of Elizabeth there were over 900 distinct swans marked, and there was an officer of the crown, termed the royal swanherd, who exercised jurisdiction over the entire kingdom. Its beautiful white plumage has made the expression "as white as a swan" proverbial; although over 200 years ago the proverb lost its force when the Cygnus melanocorypha or nigricollis was observed by Narborough on the 2d of August, 1670, in the Magellan Straits. It was found in different localities about South America, so it may be termed a typical South American swan. It is of large size, and a bright red nasal knob upon its beak, with large black neck and very bright plumage. In Europe, where it has been introduced, it breeds quite freely in confinement; although perhaps less popularly known than the white swan, it really antedates it in discovery, for the black swan of Australia was only found in 1697. The engraving gives an excellent idea of this beautiful bird.



THE BLACK NECKED SWAN.

FOREST PRESERVATION IN BADEN.

THE Grand Duchy of Baden is a part of the empire of Germany where forestry has reached the highest conditions. Only persons are appointed as forest officials who have passed a successful examination under the state officials, and have been declared competent in the science of forestry. Forest officers appointed by landlords, town authorities or corporations must be approved by the state. All forest officers, and the entire forest service, are forbidden to sell wood or any other product of the forest, or to engage in any business in which wood or forest products is the chief article of business. Only with agreement of the state authorities, and those having the appointing power to service in forest work, can the privilege be obtained to buy wood, to graze cattle, to sell grass, or to cultivate the land.

The forests are to be so cultivated that by the cutting down and removal of old, large trees without loss of time the young forests can take their place. The entire clearing of a wood or forest cannot, except for special reasons, and then only with the consent of the state officials, be allowed.

For the purpose of keeping the forests young, in accordance with natural laws, the following ages must be approximately allowed to the various trees:

	Years.
In highland forests, oak	120
Beech	70
Red and white fir	70
Scotch fir	70
In lowland forests, hard wood trees	25
Soft wood trees	15
For tanning and timber wood	12

In forests of mixed woods the felling will be governed by the period of years prescribed for the trees which most prevail. That is, in a forest where the ratios are five pines, seven birch and twelve oak trees, the cutting will take place at the time assigned for cutting oak. In cases where a doubt exists, the limit of hard wood shall be taken as the limit.

In the highland forests the trees must be so trained that the outermost branches of one tree will almost meet those of another, and shall also be kept in such a manner as to allow the entire woodland to be covered with seed. In the case of leaf-bearing trees and needle-bearing trees, with the exception of white fir, small openings will be permitted for light. When under the protecting shade of the larger trees a growth of young trees appears, the large trees can be cut away after the little ones have obtained the height of from three to five inches. But all the large trees shall not be cut down at once, but shall be cut down at two or three periods. Red fir and Scotch fir will be allowed to be cut down in the first period. The young growth must, from time to time, even until the wood is ready for felling, be thinned out, and especially must the trees of stunted growth be rooted out. In the forests of low-growing trees enough of the best old trees are to be spared and kept for seed purposes.

The wood, with the exception of timber wood, must not be cut, except in the time between the beginning of September and the end of April. In cutting the oldest trees those most fully developed are to be cut first. In mountainous districts the cutting must begin above, and the trees must be so felled, row upon row, that it will not be necessary to drag them through places planted with young trees. Traveling through places planted with young trees is not allowed. If, however in such a place trees needed for especial use, and not to be found elsewhere, are found, they can be cut down. In the matter of a clearing, especially in woods of needle-bearing trees, the cutting must be toward the west, as far as this is possible, in order that no harm can come to the trees from the inblowing winds. If this cannot be done, a certain number of trees must be left on the west side as a mantle against the sharp winds.

In felling trees, where they are not rooted out, they must be cut as near to the ground as possible. When cut with an ax the stump left must not be over 5 in. high, and when cut down with a saw, not over 8 in. Wood under 4 in. thick may be cut down with the ax, wood over 4 in. thick must be sawed. The cutting must be done in such a manner as to cause as little injury as possible to young growths or neighboring trees. In low-growing trees the cuttings must be made with very sharp axes, since the splitting of the shoots is not allowed. Trees that are felled in places where seed has been sowed must be removed at once after being felled. For brooms for stables, for strips for binding bundles, for pea and bean poles, the young trees can be cut down only when they are misformed or remain stunted. Willows must not be cut for any such purposes. The tearing off of limbs from the trees is strictly forbidden, but the dry and withered limbs may be broken away by hand, but in no case must they be cut away by tools. Regular days for the gathering of the waste wood must be appointed by the owners and forest officers in conjunction. The districts in which

the wood may be gathered must also be announced. The cutting or manipulating of the timber wood in a forest where young trees are growing is strictly forbidden. Such timber can only be so much prepared as is necessary to secure its safe transportation. The rooting out and cutting of stumps is allowed only when no growth is again expected. Wherever a stump has been dug out the ground must be leveled up. Wherever a young growth of trees is found and wood must be piled up in its neighborhood, it must be so packed and piled as to do as little harm as possible to the young growth. The carrying away of the wood by drags is forbidden, except over snow, or in places where other methods are not possible. Cutting, chopping and all other kinds of work on wood products in the forests by night is forbidden.

The clearings must be made within the time from September to April, inclusive. If the clearing is to be made in the mountain heights, among swamps, or on any timber land where it is not possible to bring it all out before the 1st of May, then the forester can make an allowance of time, but for a continuance of the privilege from year to year application must be made to the state authorities. No part of the forests must be left barren. All unnecessary paths, ways and gullies must be filled up and planted.

Cord wood for burning must be piled 6 ft. high, 6 ft. wide and 6 ft. long. Wood 4 in. thick or thicker must be split. All less than 4 in. in diameter will be left round. If the wood is made up into bundles, then must these bundles be 4 ft. long and 1 ft. thick. Because of the difference of measures in different parts of the land, the forest officers can allow the privilege of making up cords and bundles to meet the export trade. Those persons having the right to cut wood will receive the same quantities as before, but it must be measured in accordance with the new measure.

Every wood and forest within five years after the enactment of these laws must be measured, staked with boundary marks, having the boundary defined and described, and must be so marked for cutting that when the last in a series of cuttings is finished, the first of the series shall be ripe to begin the series of cuttings again. For the purpose of registering the measures, limits of boundaries and estimates for each cutting, expenses shall be paid from the department of forestry, and copies of the boundaries shall be deposited in the bureau of forestry. A new survey will not be necessary where land has once been surveyed, and the plans of the same have been deposited and the old measures can be exactly reduced to the new legal measure. Should the owner of a forest fail to have survey and definition of boundaries made within the specified years, by giving good reasons why it could not be done, the extension of time may be granted.

Such regulations as the above show the care and protection which forests receive under the German laws. Many excellent hints can be secured from these regulations, in the care of American forests, but, of course, under present conditions of forest property in this country, and present value of wood and timber, it can scarcely be expected that forest owners will show the same care and regard for their property as does the German forester. Again, our country has never yet developed that paternal care for forests which is exhibited under the workings of the European governments. Perhaps this is not necessary at present, but a knowledge of what older nations are doing in Europe is important, as an element in the education of those who are to have the charge of American forests in the future, when they become of most value and even greater importance to our national prosperity than at present.—The Paper World.

THE ANDRÉE POLAR EXPEDITION.

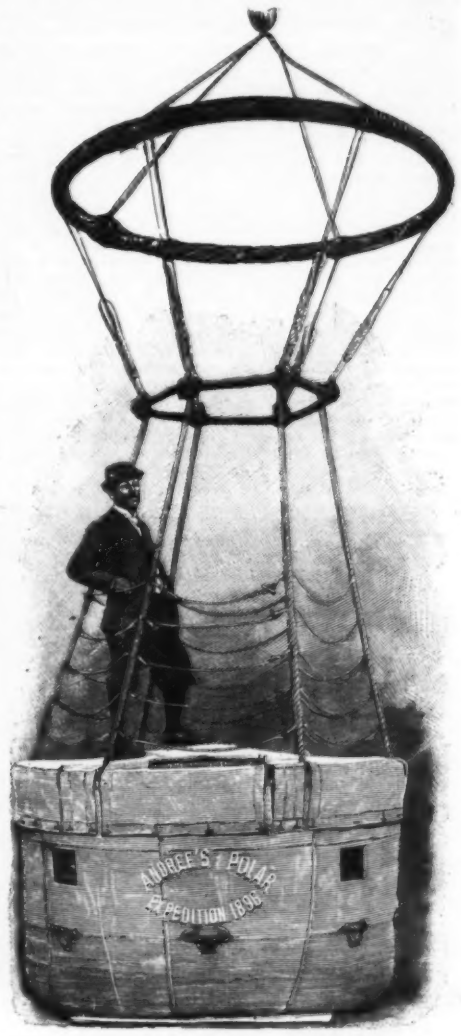
THE Arctic explorer is peculiarly dependent upon the weather, and certainly no explorer is more so than he who depends upon the atmosphere to carry him to the goal. Dr. S. A. Andrée, baffled by contrary winds, has returned at about the same time that the world was ringing with the exploits of the brave Nansen, so that the fame of the latter has rather eclipsed that of the Swedish aeronaut. It is certainly irritating that Dr. Andrée should be turned back through no fault of his own after making preparations of the most elaborate character, but he hopes for better luck another year. There were three members of Andrée's expedition. Dr. Andrée himself, who is forty-one, is an engineer by profession, but has recently held an important government post in Sweden. He stands over six feet high and is well built. Dr. Nils Ekholm, who is nearly fifty years of age, is a meteorologist of reputation. In 1882 he led a Swedish scientific expedition to Spitzbergen, when, curiously enough, Andrée was a subordinate. The third

DR. ANDRÉE.

member of the party, Nils Strindberg, who is hardly twenty-four years of age, has devoted himself to science with considerable success.

For many years Dr. Andrée has been a balloonist and has made many ascensions for scientific purposes. It is only recently, however, that he has given his attention to the possibility of reaching the pole by means of the atmosphere. When he published his plans and supported them by arguments and experiments he had little difficulty in obtaining adequate financial support from Alfred Nobel, Baron Oscar Dickson and the King of Sweden. The total cost of the expedition is estimated at $36,000.

The balloon was built in England at a cost of $10,000, and is about 75 feet in height from the opening of the balloon proper to the top, and, roughly speaking, a hundred feet high from the top to the bottom of the basket. It is made of three thicknesses of silk, held together with varnish and overlaid with two coats of varnish. The guiding and steering apparatus may be regarded as the most novel feature of the balloon. The apparatus consists mainly of three guiding ropes of different lengths, the shortest being about 1,000 feet long



THE BALLOON BASKET.

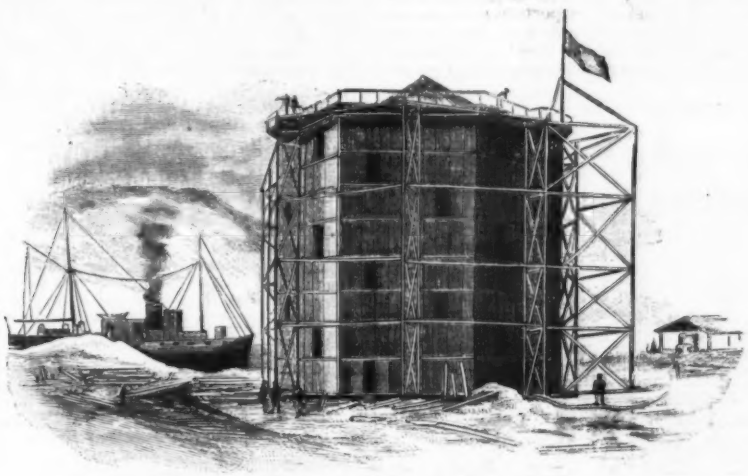
and the longest about 1,200 feet in length. These ropes hang from the bearing ring just above the car and drag along the earth or ice. These guiding ropes drag after the balloon and are shifted by the voyager as he wills

THE ANDREE POLAR EXPEDITION—BUILDING THE BALLOON HOUSE AT SPITZBERGEN.

so that their weight and hold on the balloon would affect its course in one direction or the other.

Within the net is the mainsail, and outside there are two other sails, stretched on bamboo poles, the whole sail area being 94 square yards, or a quarter of the cross section of the balloon. The sail is attached by three straps to the strong iron ring, and stoops forward so that the wind tends to lift the balloon. The basket, or gondola, as Dr. Andrée calls it, is suspended from the netting.

This gondola, and the apparatus attached to it, is a perfect wonder of ingenuity and contrivance for the storage of provisions, instruments, ammunition, and what not. The gondola itself is about 5 feet deep,



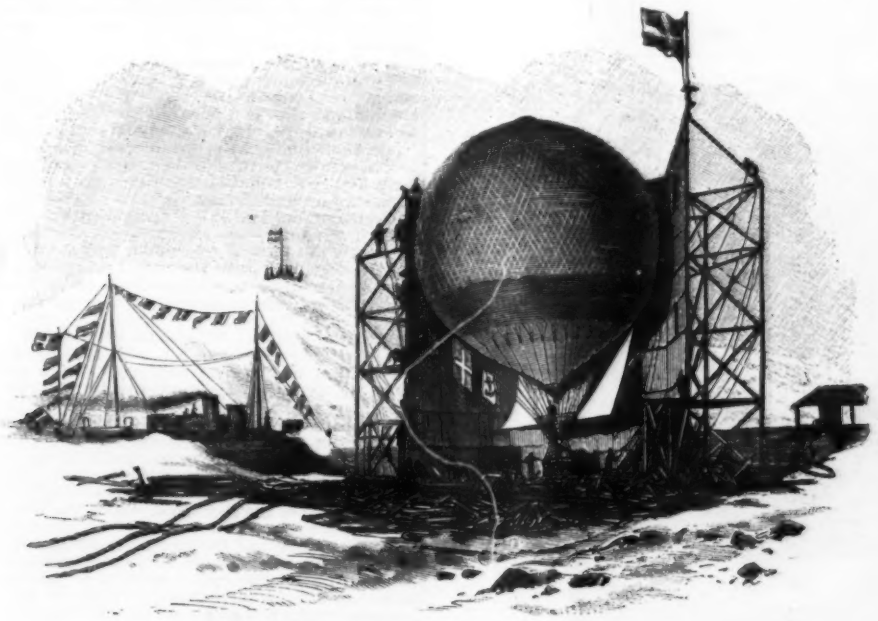
THE BALLOON HOUSE IN SPITZBERGEN.

quite round, with a wicker cover. In it is a bedstead for one person, the arrangement being that one person shall sleep while two watch and make observations. These observations will be made from the top of the basket. The travelers will stand on the lid of it, and will have around them, in a ring breast high, all the instruments which they will require for their observations.

For cooking, an apparatus will be dropped drown 15 feet below the basket by means of a rope. It will be lighted by pulling a string. And when the cooking is done the fire will be put out by pulling another string. Then the food will be brought up to the basket and eaten. These precautions are taken to obviate the danger of having a fire too near the gas of the balloon. This cooking apparatus is the invention of a Swedish engineer, devised purposely to meet Dr. Andrée's requirements.

The balloon carries 4,400 pounds, including ballast, provisions for four and one-half months, scientific instruments, guns, and 1,500 rounds of ammunition. Our engravings, for which we are indebted to L'Illustration and to Illustrirte Zeitung, give a portrait of Dr. Andrée, a view of the car and the erection of the balloon house on the bleak shores of Spitzbergen.

A balloon house had to be erected on the island from which the voyage was to begin, to be used in filling the balloon. In the smaller accompanying engravings we show two views of this house, in one of which it is represented as closed, while the other shows it open with the balloon ready to be released. This house was constructed by Ivan Svedberg. It is an octagonal wooden building, 18 feet 8 inches in diameter and 65 feet 7 inches high. Each story consists of a framework composed of eight vertical frames connected by a horizontal frame. Four such octagonal structures are placed one above the other, and the vertical parts screwed together, thus forming the skeleton of the building. The walls are formed of slides composed of wood and fabric and fitted to slide in grooves in the horizontal frames. These slides are just the right height for one story, and some of them contain windows made of a newly invented gelatine-like mass strengthened by wirework formed in the mass. An exterior gallery runs around the building near the top. From here the balloon will be raised by means of lines when it is necessary to provide it with a gondola a short time before the departure. In order to protect the balloon during this critical period, a temporary extension of fabric can be set up which will extend 14 feet 9 inches above the building. The gallery is reached by two flights of stairs on the outside of the building. A roof of fabric prevents the balloon from starting on the journey alone in case it is too lightly loaded or the fastenings which secure it to the walls of the building should loosen. The roof is also a protection from rain or snow. The building stands on a wooden foundation provided with a system of wedges, so that, if necessary, one or another part of the building could be raised.



THE BALLOON READY FOR RELEASE.

A SAFE, EFFICIENT AND ECONOMICAL DEPILATORY.

DR. A. W. DRAYTON, editor of the Indiana Medical Journal and professor of dermatology in the Medical College of Indiana, speaks very highly (Medical and Surgical Reportor) of calcium sulphydrate. It is recommended as a depilatory by Watt and Boettger, also by Kaposi in the last edition of his well known work on diseases of the skin.

Calcium sulphydrate (CaH_2S_2) is best prepared by passing sulphureted hydrogen gas through a thick cream of well slaked lime until the lime will absorb no more of the gas. It requires about two hours to make a pint. The apparatus should be set up in a fume chamber or else in the open air.

The solution thus prepared has a sharp, bitter taste, an alkaline reaction, and is moderately caustic. The chemical change is expressed as follows:

$$CaH_2O_2+2H_2S=CaH_2S_2+2H_2O.$$

Kaposi states that pastes are better than razors for the palliative treatment of disfiguring hypertrichosis. He recommends the caustic Oriental paste, known in Eastern harems as "rusma" and used to destroy the pubic and axillary hair. It is made of yellow sulphide of arsenic, ½ ounce; unslaked lime, 8 ounces; mixed with water to a paste, and boiled. It is put on by means of a spatula, left ten minutes till it dries, and then scraped off with a dull knife. The skin is then washed, dried, and powdered. This is probably the oldest and best known Eastern depilatory; it has been used for ages among the Jews "for the periodical removal of the stubble of the beard." The fact that it contains an arsenical compound seems to debar western people from its use.

Dr. Drayton admits that efficient depilatories are to be had on the market, but complains of their secrecy and excessive prices. The ordinary depilatories, in his opinion, are worthless; barium sulphide and sodium sulphide do not remove the hair. Such a depilatory as sulphydrate of calcium paste has a wide field in genito-urinary and abdominal surgery. It is antiseptic and alkaline; it is, therefore, an efficient soap and bleaching agent: the skin after its use is much whitened by the removal of dirt and superficial epithelium and oil, as well as by the removal of the hair. The hairs are destroyed some distance down in the mouth of the follicle—much closer than by shaving.

PASTEURIZED VS. STERILIZED MILK.

By ALBERT R. LEEDS, Ph.D.

THE delivery and sale by the milk dealers of our larger cities, as a regular part of their daily business, of so-called pasteurized or sterilized milk has already grown to considerable proportions. It is therefore important to consider whether this new industry does not also necessitate new sanitary precautions.

In the first place, if the process has not been successfully carried out, the pretense of doing so involves two serious frauds; first, the purchaser pays more than is asked for common milk; and, second, he is led to misplace his confidence, and even to dispense with a precaution which he would or could exercise himself—that of sterilizing in a home apparatus.

As a matter of fact, my own experience with commercial sterilized milk is that 30 per cent. of it is not sterile.

The necessity is therefore apparent that the dairy commissioners and milk inspectors should enlarge the sphere of their previous labors, and guard the public against these new dangers by making bacteriological as well as chemical examinations.

In this connection a curious reaction in public opinion is worthy of note. As with the cry of "Wolf! wolf!" in the ancient fable, so with the great hue and cry of bacteria, which rose to its acutest pitch and vehemence about four years ago. To impress duly the public mind, the countless victims of bacteria should fall stricken on the public highways as if struck by thunderbolts from heaven. But when to the vulgar gaze nothing manifestly different from what they had been accustomed to happened, a reaction of incredulity set in. Some years ago it was seriously advocated in many quarters that the entire milk supply should be sterilized, in order to escape possible infection from tuberculous cattle, contaminated water, and septic conditions in stable, dairy, and handling. At the present hour a more enlightened public opinion recognizes that both economy and hygiene demand a radically different course, which is a universal system of prevention and prophylaxis, and not primarily a system of cure. The training of dairymen in the needful hygienic requirements of their business, and a competent inspectorial supervision of cattle and milk, is now the direction in which strenuous effort is being made.

The business in sterilized milk does not grow out of an apprehension that ordinary market milk is or may be dangerous, but from a very limited demand, usually prompted by the family physician, that the infant, invalid or sick person may have a safer and better keeping milk. In the winter season this demand is very limited, but in the summer it grows considerably larger.

And when we come to examine more carefully the nature of this demand, we find that it is not for sterilized milk rightly and properly so called, but for pasteurized milk. Almost all the sterilized milk supplied by milk dealers is used within thirty-six hours, and it is rarely the case that by reason of transport by rail or ship it must be kept for an indefinite period. The consequence is that the dealers are now installing apparatus primarily designed to pasteurize milk. Even such an apparatus involves as much outlay for plant, fuel consumption, and handling, as the consumer is willing to pay for. About seventy-five minutes is requisite to raise the temperature of the flasks to 160° F., at which temperature they are maintained for half an hour, and then cooled to 50° as rapidly as they can be with safety. All the ordinary pathogenic bacteria are destroyed, and the others which remain do not develop at common temperatures to such an extent as to interfere with keeping for forty-eight to seventy-two hours longer than the same milk would in a non-pasteurized condition.

Milk thus pasteurized has very little of the taste of boiled milk or of milk which has been truly sterilized at temperatures considerably above the boiling point. And it exhibits a peculiarity in the way in which the solids are brought together by the process of heating. In milk sterilized above 212° there is a tendency of the separated fat to gather at the top in a semi-buttery, cheesy mass, and for some of the proteids to settle out as a white precipitate at the bottom. This tendency is less marked with pasteurized milk, the separated masses of fat and proteids floating about in a diffused condition. Common sweet milk can readily be filtered through ordinary filter paper. But in one sample of commercial sterilized milk which I have examined I found that out of a total of 13·5 per cent. of milk solids 3·79 per cent. was held behind by the filter. A similar sample of commercial pasteurized milk, but containing 13·31 per cent. of milk solids, left in the filter 4·91 per cent.

The best flasks for the purpose are those of Schier. They are cylinders tapering into a cone, and with the rather narrow mouth closed by a flat rubber disk setting down into a conical seat. After expulsion of air and steam the atmospheric pressure forces the disk very firmly into its seat, and the simplicity of the contrivance permits every part to be thoroughly washed and sterilized. As retailed in such flasks, sterilized milk costs four cents per half pint.

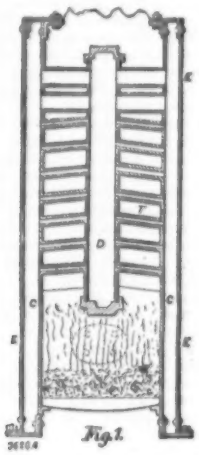
Viewed from an everyday, practical standpoint, the result of a general consideration and trial on the part of the medical fraternity, and also of the general public, has been a decision in favor of pasteurized vs. sterilized milk. The grounds—clinical, chemical, and gastronomic—upon which the verdict unfavorable to sterilized milk (except where absolute sterilization is imperative) has been asked for and obtained have already been detailed at length in other places. The use of pasteurization for a part of the city supply, and the dozens of contrivances now in use by the dairyman for pasteurizing milk intended for transit to the creamery and in preparing cream for butter making, all point in the same direction.—Dietetic and Hygienic Gazette.

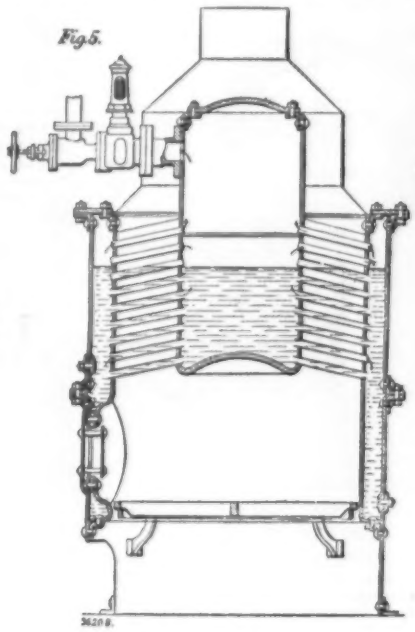
St. Petersburg is about to rebuild the Troitsky Bridge over the Neva.

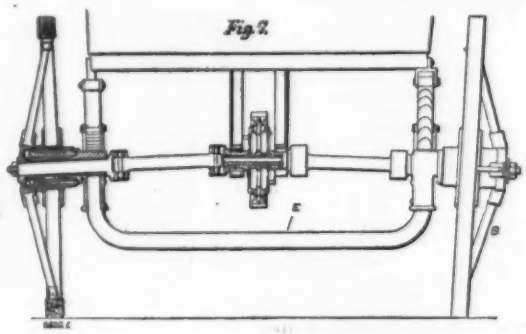
THE DE DION ET BOUTON ROAD MOTOR.*

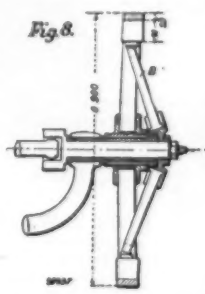
ANOTHER great competition of road motors is now being arranged in France for next October; in due time we shall give full description of this interesting event, and shall very shortly be able to furnish the programme. The principal French constructors of this class of vehicle intend to take part in the competition, and conspicuous among the motors will be a hauling engine, constructed by Messrs. De Dion and Bouton, with which it is intended to draw from Paris to Marseilles one of the enormous three horse omnibuses of Paris. The present is, therefore, an appropriate time to resume our series of articles on French road motors by describing in detail the principal types of traction engines designed by Messrs. De Dion and Bouton, of Paris. It may be mentioned that these two names, which are now so closely associated, became so almost by accident; the Comte De Dion, who is an amateur engineer, associated himself with M. Bouton for the purpose of introducing a boiler of a special type, which we shall have occasion to describe in the course of this article. It appears that this boiler has very high steam-producing qualities with a relatively small weight and volume, and it was the adaptability of the generator to power vehicles that first induced them to turn their attention conjointly in this direction; the success which they have attained is, in fact, chiefly due to the generator.

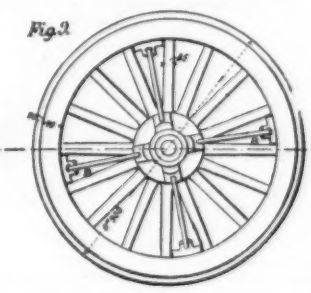
The first De Dion and Bouton road motor was placed on the streets of Paris as long ago as 1884; as may be easily supposed, it was an experimental and altogether crude contrivance, very far from presenting the same appearance of convenience and even elegance to which the modern vehicles of Peugeot, Panhard and Levassor, and others can lay claim. There was no mistaking the unfavorable impression which this first experiment produced. Both generator and engine were strongly en évidence, the latter being in front of the two persons for whom accommodation was provided on a back seat. The vertical boiler was also in front of the vehicle, and the platform carrying it, as well as the motor and the seat, was attached to a frame that rested on four wheels by single springs in front and double springs at the back. As a matter of historical interest we may give the exact dimensions of this first experimental carriage. The length of the frame was 70·87 in. and the wheels were placed 63 in. apart, from axle to axle; the floor of the vehicle was 21·66 in. from the ground, and the seat was placed at a height of 35·43 in. Power was transmitted to the front pair of wheels, which were 47·24 in. in diameter, the rear wheels, which were used for steering, being 31·50 in. in diameter. The type of wheels was that of the cycles of the period, very rigid, and formed with light round, iron spokes, the tires were protected by rubber: this was an important improvement on me-

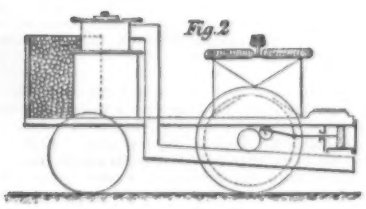


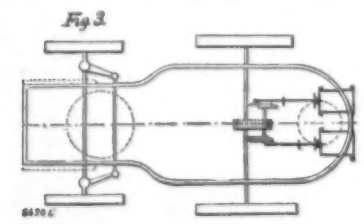


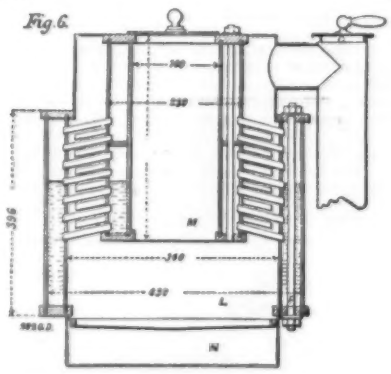












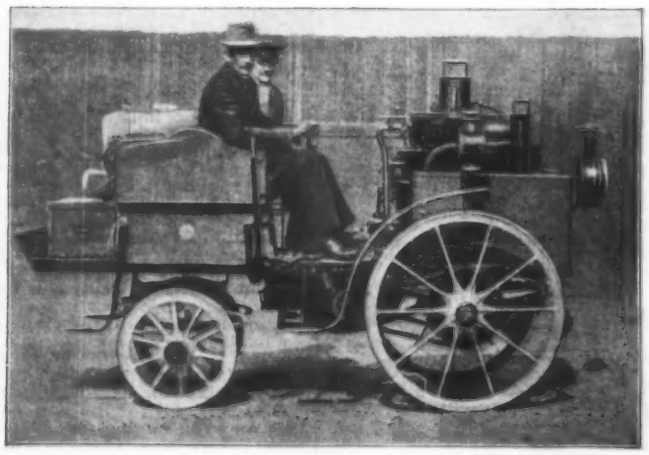


FIG. 4.

THE DE DION AND BOUTON STEAM GENERATOR AND ROAD MOTORS.

chanical carriages of the time, and the first De Dion and Bouton machine had at least the advantage of being comparatively noiseless. The rear steering wheels were loose on two independent axles, on each of which was a crank formed by a coupling rod; on this was attached the steering lever placed to the right hand side of the conductor. The boiler was of the De Dion type referred to above, and at that time was claimed to be a new system. It is illustrated by Fig. 1, above, and consists of a double envelope, E and C, forming the body of the boiler, and to which all the ordinary boiler fittings were attached; the firebox was placed in the lower part of this envelope, in the center was a cylindrical tube, D, connected to the inner shell, C, by a number of inclined and radial tubes, T. The efficiency of this boiler seems to have been satisfactory, especially for the purpose for which it was being used; an average evaporation of 9 lb. of water per pound of coke was obtained. An automatic constant level feed water device was attached to the boiler, so that as long as it operated properly the boiler required no attendance as to the water supply. This automatic feeding apparatus consisted of a double-acting pump, driven direct by a motor to which steam was supplied, taken from the boiler at the normal water level. The exhaust from this motor discharged into the water tank so as to raise the temperature of the feed. In order to enable the steam pressure to be kept up when the ashpan was closed tightly, a condition often necessary when running, two steam jets were introduced beneath the grate for inducing a mixed jet of air and steam.

The carriage was driven by independent oscillating engines with a cylinder 2·76 in. in diameter and 4 in. stroke; a speed of 25 miles an hour corresponding to a speed of 900 revolutions per minute.

The exhaust from the engines entered an envelope that surrounded the firebox, the object of this arrangement being to cool the walls of the firebox, and at the same time to superheat the steam, so that it might, on escaping into the air, be invisible and comparatively noiseless. In addition to the steering lever, the conductor had on his left hand a controlling lever, which operated two coupled Prony brakes; by means of these the speed could be reduced or the carriage stopped, the brake straps acting on the two large wheels in front. The carriage itself weighed 286 lb., to which had to be added 400 lb. for the boiler and fittings; the motor weighed 55 lb.; the feed pump, 22 lb.; the spare tools carried 33 lb.; 70 lb. of coke and about 20 gallons of water were also carried, so that the vehicle in working order weighed nearly three-quarters of a ton. Defective as this first experimental machine necessarily was, it proved itself capable of doing considerable work, and on several occasions recorded a maximum speed of 25 miles an hour; it was also able to turn on a radius of 8 ft. These early experiments attracted considerable attention, although the time had not yet come for any serious consideration of the use of mechanical road traction in France. Though Messrs. De Dion and Bouton do not appear to have closely followed their first trials, they did not by any means abandon their experiments; but when in 1894 the proprietors of the Petit Journal organized their famous competition between Paris and Rouen, the two enterprising experimenters did not hesitate to take part in the competition. They had every reason to be satisfied with the result, for although the first prize was divided between Messrs. Peugeot and Panhard-Levassor, the second prize was awarded to Messrs. De Dion and Bouton, at the same time that a similar recognition was given to Mr. Le Blant.*

As a matter of fact, Messrs. De Dion and Bouton had not been idle since 1884, since in the following year (1885) they placed on the streets of Paris a second carriage, which is illustrated in Fig. 2. But little space need be given to describe this second vehicle, the arrangement of which is clearly shown in the engraving. Generally speaking, it closely resembles the type of 1884; the steering wheels were much smaller than the driving wheels; they were placed at the back, and a pitched chain transmission was used instead of a belt. The vertical chimney of the generator, which was not only unsightly, but was an intolerable nuisance in the streets, was somewhat improved by bending it downward beneath the carriage. But in spite of these alterations, the result was unsatisfactory on account of its clumsy appearance and the large amount of space occupied by the motor, which was placed on the front part of the carriage. For all that, it was a practical road motor, and gave good proof of its solidity and efficiency by making a satisfactory run between Paris and Royan, a little town at the mouth of the Gironde.

Very different to the 1884 type was that of 1889, which was not a motor car, but a steam traction engine, in which the motor was carried instead of forming part of the actual vehicle. The inventors elected to call it a steam bogie; as a matter of fact, it was neither more nor less than a small road locomotive designed to take the place of a horse. This pattern is illustrated by Fig. 4. The first impression it conveys is that of unnecessary weight and clumsiness, but the constructors, having an essentially practical end in view, were endeavoring to develop a motor that could be usefully applied to haul any class of ordinary vehicles, and that could be used under very different working conditions, according to whether it was required for re-

* From Engineering.

* See Engineering, vol. lxi, page 6.

latively high speeds or heavy roads. It was a motor of this type that was coupled to a four seated victoria in the Petit Journal competition of 1894. On that occasion it left Paris at eight o'clock in the morning, the same hour at which the other vehicles started, and was the first to arrive at Rouen the same evening at 5:40. This trial proved beyond doubt that the machine possessed powers of resistance higher than any of the petroleum motors that took part in the competition. The motor was carried on a horizontal frame formed of U-shaped bars 2 in. deep and resting on the axles by springs; this frame carried the motor, boiler, water tank, and fuel store. The boiler, which was a modified form of the type already described, was almost completely surrounded by the fuel tank; as to the chimney, it is turned back under the carriage, as is shown in the diagram, Figs. 2 and 3. The back of the frame is left free, and carries a ring, to which is hooked the front of the vehicle to be hauled, and from which the fore carriage has been removed; this ring is mounted upon springs. The machine is on four wheels, of which the back pair is used for steering; they are controlled by a system of cranks very similar to that already described, and the arrangement of which is indicated on the diagram, Fig. 3. The wheels are of the cycle type, and the tires are of rubber 3·15 in. wide. It may be mentioned here that these tires are formed of separate bands of rubber 0·59 in. thick. The rear wheels are only 2·76 in. in width, and have iron tires; they are built of wood, with an iron boss, and have several peculiarities to which attention may be called.

Before speaking further of the motor, a few words may be given to the steam generator; it is of the same type as that used in the carriage in 1884, and illustrated in Fig. 1, but several modifications have been introduced. It is illustrated by Fig. 5. These boilers are guaranteed to generate from 4·5 lb. to 6 lb. of dry steam per square foot of heating surface, and from 7 lb. to 8 lb. per pound of coal, using natural draught. Any question of trouble and maintenance apart, it is evident that the large number of small radiating tubes employed presents a relatively large and very efficient heating surface, which insures rapid generation of dry steam. A large number of these boilers is now being used in France, and among other well-known makers of them are Messrs. Sautter, Harlé & Co. From trials recently conducted by this well-known house, it appears that a De Dion boiler, weighing 1,430 lb. empty, with a heating surface of 64·5 square feet and a grate surface of less than 3 square feet, consumes 88 lb. of coal per hour, and generates 550 lb. of steam.

We may add apropos of this type of boiler that the radiating and inclined tubes constituting a special feature are so arranged that each one is placed immediately above the free space left between two tubes in the adjacent row; this arrangement assures a free circulation of the heated gases. The steam space is situated in a part of the boiler where the temperature averages 250° C., so that the steam is kept dry without being superheated. It may also be noted that in consequence of the inclination given to the tubes a greater elasticity is secured, so that there is no danger of the tubes moving in the tube plates under the influence of expansion.

Some modifications have been introduced by Messrs. *De Dion* and Bouton in their latest type of generator which is illustrated in Fig. 6. The boiler is intended to burn coke almost entirely, and the fuel is introduced through the center as in a portable stove. This form consists of two rings connected by the usual inclined radiating tubes. The upper part of the rings above the water level serves as a steam space, and steam is taken to the motor from the top of the inner ring; a circular diaphragm is introduced to prevent water being taken over with the steam, to facilitate the rapid dismounting and cleaning of the boiler; the bottoms of the two rings are closed by circular pieces connected together by the bolts, F. The fuel is fed into the center, being introduced by the passage, M, which is closed by a light sheet iron cover; the grate is shown at L and the ash-pit at N. The gases of combustion, after having passed around the tubes, enter the chimney, and are discharged beneath the vehicle; the chimney can be cleaned by the soot door, O. This boiler has a fire grate 13·4 in. in diameter, while the diameter of the internal rings is only 6 in. The ordinary working pressure does not exceed 9 atmospheres, but it is registered to a far higher pressure. The number of tubes is 816, divided into 21 rows, there being 40 tubes in 20 of the rows; the tubes are of copper, 0·39 in. internal and 0·51 in. external diameter; the length is 4·40 in. The heating surface is about 24 square feet and the grate surface is less than 2 square feet. The total weight of the generator is 530 lb., and the production of dry steam is very large. The boiler is fitted with a reheater at the side of the firebox; this is a flattened and bent steel tube protected against the direct contact of the fire by a cast iron shield.

The motor is placed on the carriage beneath the platform; it is a compound engine with two cylinders, and is large enough to furnish the power necessary for propelling itself and another carriage. The stroke of the pistons is 5·11 in., the diameter of the small cylinder is 4·72 in., and that of the large cylinder is 7·08 in.; the cylinders are separated by an intermediate receiver, and an automatic oiling device insures continuous lubrication. For the sake of simplicity there is no variable expansion or reversing gear, but, when desired, full pressure of steam can be admitted into both cylinders. The engine is rated as being of 20 horse power. This motor is coupled to an intermediate shaft, on which is a pinion that gears into the spurwheel on the driving wheel shaft; the ratio of gearing is 2·81 and the running speed is 330 revolutions a minute, in order to give a rate of 12·5 miles an hour to the vehicle. The weight of the traction engine in working order is 2 tons, and the constructors claim that it can haul a load of 2½ tons at a rate of 20 miles an hour on level ground. It can carry a coke supply sufficient for a distance of 60 miles, and enough water for 25 miles. The water tanks are placed beneath the seat.

The De Dion and Bouton motor has a special arrangement for the transmission of power to the driving wheels, to which we may now call attention. The engine power is transmitted with a reduction of speed, not to the axle but to the rim, the intention being to insure a longer life to the wheels by avoiding the strain on the spokes to which they are exposed when the power is transmitted through them. The pitched chain transmission is also abandoned, which is certainly not an unmixed advantage. Figs. 7 to 9 show the arrangement to which we have just referred. The axle, E, is bent, and at each end it is placed in an axle box, on the top of which are the suspension springs of the vehicle. This box is traversed by a sleeve which the motor rotates by means of an articulated shaft. The sleeve carries the wheel, but it is longer than the boss, and the end which extends beyond this latter is cut square and forms the center of a four-armed star, B', connected to the rim of the wheel by the ends of the arms. These ends enter recesses in the rim. It is claimed for this arrangement not only that there is less wear on the wheels, but also that the four driving arms, on account of their elasticity, deaden shocks in passing over a rough road.

(To be continued.)

A FAMILY BICYCLE.

THE accompanying engraving is reproduced from a photograph representing Mr. H. J. Von Scheidt, of Buffalo, N. Y., and his four boys mounted upon a bicycle of special construction upon which they have been riding about the country every day during the seasons of 1895-96. Mr. Von Scheidt began riding in 1893, carrying at that time but one of his boys. Each succeeding year the boys became more numerous and the load heavier, until the combined weight at present is 406 pounds. Mr. Von Scheidt takes this load to Niagara Falls and return in an afternoon or evening, and often makes a run of ten or fifteen miles into the country with it.

A FAMILY BICYCLE.

THE AUSTIN CURRENT MOTOR.

THE name "current motor" is applied to a mechanism that utilizes the power of the stream or current of a river in such a way that it can be applied to run machinery. Several crude attempts have been made in the past to accomplish this, but it remained for the F. C. Austin Manufacturing Company, of Chicago, to be the pioneers of a practical current motor, and who have brought out the machine illustrated herewith.

Rivers have been utilized to run machinery by damming them and using a waterwheel, but this necessitated the expense of the construction and maintenance of the dam, and was only available where the conditions were favorable, which necessarily very much limited their use. The current motor, however, can be used without a dam in any river, in any location in the river where the water is deep enough to admit it.

There is almost no limit, the manufacturers claim, to the use to which the power generated by a current motor can be applied. For example, it may be used for generating electricity for electric lighting purposes, and for various machines used on a farm now running by steam, but its chief use will be in connection with irrigation and mining.

There are many localities in the West, and, in fact, all over the country, where the land adjacent to the river is too high to admit of the water being conveyed to it through ditches by means of gravity. Under such conditions the land is now generally not irrigated, particularly in the arid regions, except to a limited extent in those localities where vegetables and fruits are raised, where the value of the crop compensates in a measure for the expense of pumping water by steam or gasoline engine, both of which require fuel and a mechanical attendant. The capacity of the windmill is too limited to admit of its general use for irrigation on a large scale. To such localities it is claimed the Austin current motor will prove a boon.

This motor has been experimented with and tested thoroughly and its practicability practically demonstrated. The only limits to the power, and, consequently, to the amount of water that can be pumped by the Austin current motor, are the dimensions of the paddles, the number of them, and the force of the current.

THE AUSTIN CURRENT MOTOR.

The machine, which is anchored in the river, consists of a pontoon carrying two endless chains, to which are pivotally attached at suitable distances reversible paddles having floats at their upper ends that buoy them up in their course through the water.

By an ingenious device these paddles enter and leave the water in such a way that they do not detract from the efficiency of the machinery, but, on the contrary, rather add to it. To the wheels put in motion by these cables is attached an elevator carrying large buckets, which, when entering the water to fill themselves, add to the generation of power, and are so arranged that when they reach the top of the elevator they discharge their contents with the least possible friction into a trough, there to be conveyed to the shore, where a reservoir has been constructed to collect the water and distribute it through canals and lateral ditches over the land.

The first outlay for a current motor of this description is, comparatively speaking, not large, particularly when the enormous enhancement of the value of the land is considered, and the cost of running it is nominal. It works incessantly day and night without an

attendant, and, if the capacity of the reservoir is sufficient, a large volume of water is accumulated to be used at the proper season.

CHAINS AND CHAIN IRON.

By G. N. SHAWCROSS.

INTRODUCTION.—The subject of chains and the iron used in their manufacture is one that covers a very wide space, and is of great interest. The author does not intend to go deeply into the subject, but to give a short account of the qualities of iron used in chain making, and also of the behavior of chain under various conditions. The early mention of chains in the old historical books does not in any way prove that they were made of iron, and in all probability these so-called chains would not be considered as such now.

Early Use.—In 1634 a patent for mooring chains was obtained by a blacksmith named White. This was the first patent published in England, and from this date the use of chains may be said to have begun, but it was not until many years after this that chains were generally made. In the beginning of the present century considerable attention was centered in the manufacture of iron chain cables as substitutes for hempen ones, and a lot of patents of various kinds came out about this time, but their gradual adoption was very slow. In the year 1813 one of the first testing machines was put down on the Tyne, and it was supposed to test up to 80 tons; also about this time Samuel Brown, a former lieutenant in the royal navy, had a proving machine put down in his works at Millwall for testing chain, especially his own patent cable chain with twisted links. By this means he was enabled to find out where defects existed both in construction and material, and thus gradually improved his chain. In addition to this he began to test the properties of the iron from which cables were made, and so did much toward making his chains reliable.

Chain Iron.—Let us now turn our attention to the qualities of iron used in chain manufacture. Such qualities require not only a high tensile strength, but also a considerable amount of elasticity, in order to enable it to withstand the shocks continually brought to bear on it in practice. The iron from which cables and chains are made is manufactured from various mixtures of pig iron, and can be made from puddled bars, a mixture of puddled bars and scrap, or all scrap. Puddling briefly consists of heating a required quantity of broken pieces of pig iron in a furnace and exposing it to a current of air until almost molten, and thus burning out the carbon, sulphur and phosphorus by moving it about until the iron becomes pasty, and can be rolled into balls or lumps. During this process the whole of the carbon escapes as carbonic acid, and any sulphur and phosphorus is also oxidized. The balls are then taken to the steam hammer and drawn into blooms, which in turn are taken to the forge mill and rolled into bars. These bars, when cut up, form the pile out of which the required size of iron is made. The piles are reheated in the furnace and rolled into bars or rods. Bar iron made from puddled bars, mixed with scrap steel rails, should not be used for chain iron, because, though the tensile strength of the bar may be good, the iron so made is not tough and fibrous, and is therefore unfit for chains. For making small chains it is better if the iron be fagoted, rather than piled, for by this means the bars will be tougher and the bending qualities of the iron superior to that of piled iron. It does not follow that chains which stand the greatest tensile pull before breaking are the most reliable, for very often a high tensile strength is possessed by a hard, brittle iron, which is liable to snap upon the application of a sudden jerk.

Iron itself is essentially a bundle of fibers held together more or less loosely, and the presence of scale or dirt causes imperfect union of these fibers, and the result is that the interior of the bar will be unsound and open. There are great difficulties encountered in the various qualities of iron, from Yorkshire iron, with which we can do almost anything, down to the common brand of Staffordshire iron marked B. Some common iron will barely stand work done to it without cracking or its fibers opening. Again, nearly every brand of iron requires special treatment, some being what is termed "hot short" and others "cold short." Some kinds of iron also contain a great amount of dirt, so that all these things tend to prevent good working and have to be watched by the smith. Chain is made from three qualities of iron, viz.: B, BB and BBB. The first, of B quality, is termed best iron, but in reality this is the worst or commonest iron, BB iron being about 20 per cent. better, and treble iron (BBB) about 30 per cent. better. These terms used in the iron trade are misleading and ought to be done away with.

Absolutely pure iron is almost a chemical curiosity, for even the best iron contains some cinder and traces of other elements—some chemically combined, others mechanically alloyed with it. Analysis shows us that invariably red short iron contains in some form sulphur, and that cold short iron contains prosphorus. Thus, when iron is weak and cracks when worked at a red heat, we say it is due to sulphur being present; and when it cracks when bent cold, we attribute it to phosphorus.

Hot Short Iron.—Hot short iron is difficult to weld or forge, and cracks even when bent hot. This often occurs in chain making, the butt end of a link made of hot short iron showing signs of fracture when bent to shape. Iron obtained from the ores of certain districts is noted for red shortness; and, again, other districts are known for cold short iron. Some ores give iron which is both red and cold short. Naturally those ores which are freest from sulphur, phosphorus, and other injurious elements yield pig iron more suitable for producing bar iron. One way of ascertaining if iron is free from hot or cold short is as follows: The sample bar is heated to a good red heat, and a hole is then punched through it at a distance of one and one-half times the diameter of the bar from the end. The hole so made is drifted out to a size nearly equal to the diameter of the bar, according to the qualities of the material. A second hole is then punched and drifted out at right angles to the first. The bar will then have the appearance of Fig. 1.

Hot Short Test.—The end of the bar is then what is called "ramshorned," that is, split across the metal at A, and bent back as in Fig. 2. The heat at which this can be done depends on the quality of the iron. If the iron is free from hot shortness, there will be no cracking or sign of fracture at the edges of the hole, and the horns should bend on themselves without a flaw.

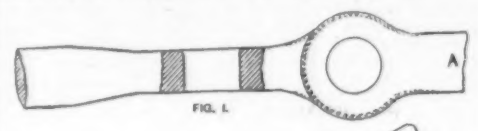


FIG. 1.

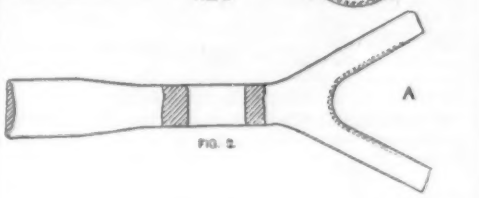


FIG. 2.

Cold Short Test.—The bars should stand being bent double over a bar of equal diameter without signs of fracture. Another way is to nick the sample with a chisel and then bend it back. This will show the fracture, which should be clean and free from cinder and grit, and of a fibrous nature. Cold short iron, due to phosphorus, although it cracks when bent cold, can often be welded or forged hot.

Injurious elements, especially sulphur, sometimes exist in the fuel used, and often in the fluxing material itself. A fair amount of loss in weight caused by forming some of the iron into cinder, to attract and carry off the harmful substances, will help to produce good bar iron, and severe pressure, as in rolling or good hammering, will extrude most of the cinder in the iron which leaves the puddling furnace.

Cheap iron does not receive the same severe mechanical treatment to expel the cinder as does the better class of iron, because it sells as bar iron at a higher rate than as cinder. A bar of good hammered Yorkshire iron will suspend a load of twenty-seven to twenty-eight tons per square inch before breaking, whereas a common quality, which has not received enough treatment during its manufacture to expel the cinder and compact the iron, will break under a load of from twenty to twenty-two tons. Even the very best bar iron often contains some cinder.

The appearance of the fracture of wrought iron varies with the way it has been caused. A good bar will, if nicked and then bent till it breaks, show a fracture which is full of bright silky fibers of a dark gray color. The same bar, if nicked deeper and broken suddenly, will present a crystalline appearance. Frequently, in the piling of puddled bars for the process of rolling into finished bars, pieces of inferior quality, containing phosphorus or other injurious elements, are built into the pile. The presence of any cold short iron thus introduced can be told by the fracture of the bar, which will have a light and bright crystalline appearance, surrounded by good fiber. Again, crystalline patches in a fibrous fracture may result from insufficient working. Such iron is known as "raw iron." The appearance of the fracture of iron is not always a reliable index to its quality, as very indifferent iron sometimes shows good fiber. As a rule, the finer the fibers and crystals are, the better the quality. Good bars have a clean, smooth skin, and are free from skin cracks.

The quality of iron is best found by the tensile testing machine, together with the smith's trial of bending it and punching near the edge while in a hot and cold state, and also by subjecting it to a good red heat to determine its welding qualities.

Welding Qualities.—One of the most useful properties possessed by wrought iron is its capability of welding when at a high temperature. In a good weld the union of the two parts is so complete that upon the application of stress there is no greater tendency to rupture at the weld than elsewhere, that is, if the areas are equal. One of the necessary conditions of welding is that the surfaces brought into contact should be free from scale. Iron, when at a high temperature, scales rapidly when in contact with the air, and scale is formed even in the smith's fire, especially if there is only a thin layer of fuel between the articles being heated and the blast. The reason of this is that the fuel does not abstract all the oxygen from the blast before it comes in contact with the iron, and so the remaining oxygen scales it. One way of overcoming scale is by the addition of a little sand to the welds, which forms a compound with the scale and dissolves it. When the ends are brought together on the anvil the hammer blows expel the liquid slag, and thus the two ends are brought together quite cleanly. Scarfed welds ought to be full in the middle rather than dished, for, if brought together in the latter case, they are certain to contain some cinder or slag, and thus weaken the weld.

When a good iron is wanted for chain making, about one-third to one-fifth of the pile which goes under the hammer should be scrap iron of the best quality. The first requisites of a really good chain iron are well known to be elasticity combined with good welding qualities and a fairly high tensile strength, so that the chain made from it may be in the best possible condition to resist the sudden shocks and strains to which chains of all descriptions are subjected. A brittle iron possessing merely the quality of withstanding high tensile strain, such as would be applied in a proving machine, is quite unfitted for use in a high class chain. The reason of this is that if a sudden load be put upon it, it would break, where an elastic iron would resist the same without detriment.

Fuel.—The fuel used in chain making varies. Gas coke, which has been riddled and freed from dirt, is generally used for both stud link and unstudded or short link chain. Some chainmakers use gas coke mixed with a little slack, and sometimes South Wales slack alone is used when gas coke cannot be obtained. Coke allows the work to be heated quickly, but, as is well known, it has a "gnawing" action, and if it is not broken up to suit the size of chain being made, it eats into the iron, and will burn the outside of the link before the inner part is at a proper temperature for welding. To prevent this action a fuel known as "forge breeze" is often mixed with the coke, so as to retard it. This fuel is prepared by burning coal in an oven until all the smoke contained in it is given up, when it is cooled by the application of water, and afterward washed and freed from dirt. Another way of obtaining this fuel is by taking the cinders used after heating a puddling furnace and plunging them into water, when those that float are raked off, and, after being riddled, are ready for use. When a link is burned it is always liable to break under a sudden shock, and should be at once cut out.

Chain Making.—We now come to chain making. When the chain is of the worst and most inferior quality, it is usually called best short link chain, and when of fairly good material and workmanship it is called best short link crane chain. In short link chain the links are about five times the diameter of the rod iron from which they are made and three and one-half times the diameter in width. There are two methods of welding links, viz., side and end weldings. For studded chain the largest size which is recommended to be end welded is one and one-eighth inches, but this is often exceeded. Chain iron is always over the ordinary size: thus, one-half inch chain iron would be one thirty-second of an inch larger in diameter than ordinary one-half inch round iron, and so on for all sizes. Therefore, when we speak of a certain size of chain, we mean the nominal and not the actual diameter. In welding short link chain the smith generally cuts his own links from the rod, if the iron be not over nine-sixteenths inch diameter. Sizes above nine-sixteenths inch require to be cut cold by means of shears. Again, up to and including thirteen-sixteenths inch diameter, the smith will work the links alone, but for sizes over that to one and one-quarter inches he requires a striker, and for one and one-quarter inches and over two strikers. The striker's duty when working is to attend to the fire, examine the links for spills, cracks, etc., to see that the anvil face is clean and free from scale, and to sprinkle some of the sand or flux on to the welds. In addition to this, he has to bend and scarf the links, and it is on his blows that the soundness of the welds practically depends, the smith being engaged in heating the links and turning them on the bick of the anvil and directing the striker's blows.

In making the smaller sizes of chain up to nine-sixteenths inch, the smith takes a bar of iron, examines it to make sure there are no defects, such as spills, etc., and heats it in his fire to a good cherry-red heat; then withdrawing it, he places the heated end over an inverted chisel point in his anvil, with the end of the bar pushed against a stop, to insure a standard length for each link. Then he nicks the bar with his hammer, bends it into a U shape, and breaks it off. This he inserts again into the fire, and gets both ends to a welding heat, which is when the iron begins to burn with vivid sparks. This heat is very variable; pure fibrous iron will stand almost any heat if protected by a slag, whereas some iron will not permit of being heated higher than a dark red before the ends burn away. When the ends are sufficiently hot the smith takes them with his tongs, and, after dipping in a little sand to form a flux, proceeds to scarf them, next bends them over his bick and hammers them together. Then the link is inserted a second time into the fire, drawn out, and again hammered to bring the ends properly together, and then it is rounded by means of a dolly, which, fastened to his anvil by a center, is dropped on to the link that is being welded. This dolly the smith proceeds to hammer, turning the link over the point of his bick iron, first one side and then the other, until it is properly shaped. While working on one link several other bars are being heated, and these are in turn bent, cut off, looped through the last made link, and welded as before, the whole operation being done in three heats. In this way he goes on until the desired length is completed. Another method of welding small sizes of chain up to one-half inch diameter is that known as "jumping." Instead of scarfing the ends as formerly, the smith simply gets one above the other, and then knocks them both into each other on the point of his bick, using the dolly to shape them. This is a quicker way, but not so good as scarfed chain. Tests made by the author on scarfed links, against "jumped" ones, showed the former to be considerably stronger than any links that had been jumped. This is easily apparent, for scarfing insures the ends of the links being properly brought together, while jumping simply knocks one end into the other, and if the links are overheated an unsound weld is the result. Fig. 3 is

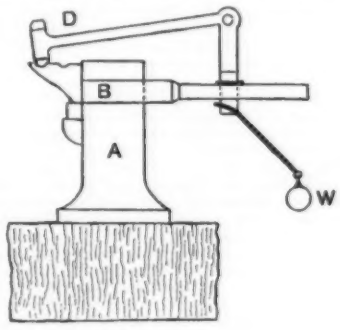


FIG. 3.

a sketch of a chainsmith's anvil, with the necessary tools attached. A is the anvil, B the bick iron, and D the dolly. The end of the bick iron is suitably recessed for the particular size of link to be welded, and the dolly head is also hollowed so that, when struck by the hammer, it may round the link uniformly. It often happens that the welded end is not the same shape as the other, being pointed and egg shaped, but this should not be the case if done properly.

Stud Link Chain.—The stud has been introduced in chain links to stiffen them, especially in heavy chains, such as ship cables, etc. The strength of stud link chains may be taken at 1·6 to 1·8 times that of the iron from which they are made, and are about 50 per cent. stronger than the corresponding size of unstudded link chain. In 1875 a special committee was appointed in

the United States to investigate the conditions under which the stud chain is manufactured and used. In their report the committee divide the link into four sections, viz., the weld, butt, quarters near the weld and butt, and the sides, and out of 435 links tested by the committee—

217 links, or 49·9 per cent., broke in the quarter near the weld.
116 links, or 26·8 per cent., broke in the weld.
65 links, or 14·9 per cent., broke in the quarter butt.
21 links, or 4·8 per cent., broke in the butt.
16 links, or 3·7 per cent., broke in the sides.

This list shows that the quarters near the weld and butt are even weaker than the weld itself. The reason of this is that the strains about the quarters are excessive, being a mixture of tensile bending and shearing strains, whereas those at the sides are simply tensile, and at the ends bending strains. Stud links can be worked much nearer their breaking load than is the case with unstudded ones. Stud links, when end welded, are done in the same manner as unstudded ones, the link being welded first, but the sides left sufficiently open to admit the stud, which is put in, and then the smith holds the link with a pair of tongs while his strikers close the sides on to the stud with sledges. A lot of care has to be taken in seeing that the studs fit the link properly and do not bind upon the edges only, for if made thus it is worthless as reliable chain. Again, the links must be slightly round on the sides, and not flat, as is often the case; and studs that are not in the center of the links are also objectionable and must be guarded against. When stud chains are side welded, the piece of iron required to form the link is usually cut off cold by shears with the ends at an angle to form the scarf, as shown at (a), Fig. 4. It is then bent in a machine until the ends are

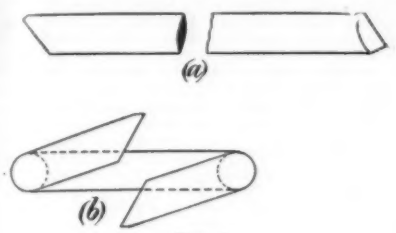


FIG. 4.

opposite each other, but not too near, so as to allow the last made link to be put through, as in (b), Fig. 4.

Each link is in turn heated and the scarfed ends closed. The shaping of the link is done by the chainsmith holding a hollow-faced tool on the parts necessary while it is struck with a hammer until properly rounded. In this way the desired length of chain is completed.

The manufacture of chain, particularly stud link and crane chain, is of the highest importance, and should be done carefully, all links being of equal strength and properly formed; for the strength of a chain being that of its weakest part, it would be unreliable and fail at a critical moment when badly wanted, and so cause delay and disappointment.—The Practical Engineer.

THE LAUNCHING OF VESSELS IN FRANCE.

THE processes and material employed in the launching of vessels are naturally very different, according as it is a question of a flat bottomed boat or an armorclad of the first class; but the principles are always the same, and it is in the launching of the smallest boats that we find them clearly indicated. The dockyard is situated right at the river side and its ground is very level. The boat is raised by jacks so as to make it mount upon ways consisting of two stringers and two slides, both of which have been previously covered with tallow and soft soap. The slides are connected with each other by crosspieces so as to keep them parallel. One or more jacks are then applied along the side of the boat, which is made to descend into the water through their impulsion.

If we now pass to the launching of a vessel designed for maritime navigation, we find a new element in the structure of it. The flat bottom gives place to a keel, under which are placed the ways, which are arranged before the construction is begun. The foundation upon which the work is begun, in fact, consists of a series of blocks of wood called stocks, and presenting the necessary slope to permit of effecting the launching. When the moment for the latter operation arrives, the upper layer of these blocks is removed and replaced by slides slushed with tallow and soft soap. These slides are driven under the keel by means of wooden wedges. During the period of construction, the keel is kept in place by two strong beams strongly cross braced. The body of the vessel is thus stayed at all parts during the construction. All these stays are removed at the moment of launching. In order to prevent the vessel from moving before the time fixed for the launching, there are used two large sized wedges, which, through their friction, prevent the sliding that gravity tends to produce. When the time arrives for the launching, two ship carpenters knock out the wedges, and the vessel, slightly trembling at first,

FIG. 2.—SECTION OF THE WAYS.

begins to glide toward the element in which she is to run her career.

Sometimes the vessel is held only by a cable, which is cut when it is desired to start her.

Up to the present, we have spoken only of the launching of wooden vessels. In those of iron or steel, whether they be sailing or steam vessels, the keel, by reason of its weight, would not have the resistance necessary to permit of the sliding taking place with it as a support. There are therefore here neither a slide under the keel nor lateral shores. During the construction the keel rests upon blocks that must disappear at the moment of launching.

The lateral slides receive the longitudinal pieces upon

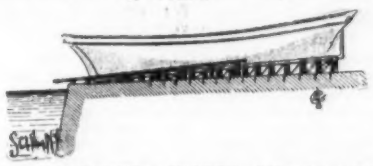


FIG. 3.—WOODEN VESSEL READY FOR LAUNCHING.

which the hull rests through the intermedium of blocks assuming its contours. At the moment of launching, wedges are driven in such a way as to slowly lift the vessel, so that the blocks upon which the keel rests may be removed. The hull is then allowed to redescend upon the slides, so that the launching may be effected.

It remains for us to say a few words concerning the launching of ironclads. The exceptional weight of such vessels renders the operation particularly delicate. These large vessels can be constructed only on slips adapted for this work, and the soil of which offers the solidity necessary to support the weight of such masses in motion. The vessel is held in place as follows: A shaft of forged iron is fixed to two wooden posts. This shaft carries a lever at whose extremity there acts a weight. The shaft also carries two hooks to which are attached the retaining bars fixed to the longitudinal pieces. Upon the side opposite the shaft there is a lever held in place by a trigger. As soon as the weighted lever abuts against the latter, it sets the large lever free, and the shaft revolves and disengages its two hooks from the eyes of the bars. At this moment the ship is free to slide toward the water. The ways upon which it slides differ in construction from those of an

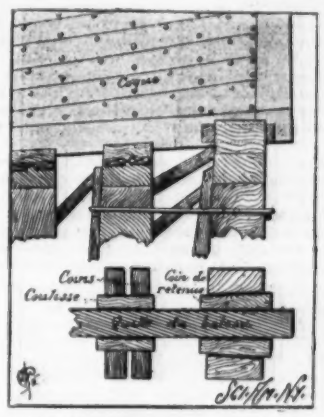


FIG. 4.—CHOCKING OF A WOODEN VESSEL.

ordinary iron vessel only in the greater care used in laying them. It is necessary to see that the string pieces are exactly parallel and that their surface is perfectly even. Moreover, they are united by metallic tie bars and cables in order to prevent distortion. The

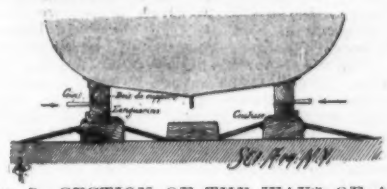


FIG. 5.—SECTION OF THE WAYS OF AN IRON VESSEL.

vessel is raised as we have already explained, and during this operation bags of sand are introduced under the front of the vessel, that is to say, under the part that is to enter the water last. This sand, which is contained in very strong bags, becomes strongly compressed under the action of the weight of the vessel. At the moment the latter is given its liberty to move, these bags are broken open and the violently projected sand gives the vessel its first impulsion. If this process does not succeed, a hydraulic ram is used in conjunction with it.

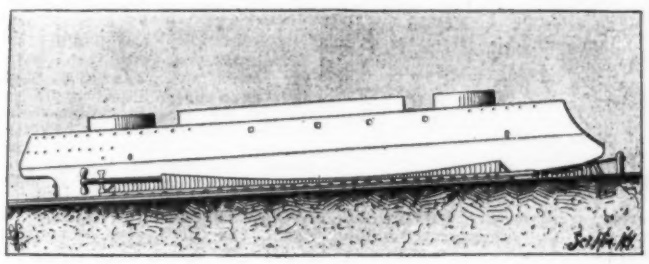


FIG. 6.—IRONCLAD READY FOR LAUNCHING.

As soon as the ship enters the water, it is necessary to stop it. If there is sufficient space ahead, anchors are cast, otherwise there is used an arrangement consisting of a chain attached on the one hand to the vessel and on the other to an iron wedge of large size, that engages in its recess with hard friction as soon as the boat has reached the distance that the builder has fixed upon. The friction suffices to arrest the motion.—La Vie Scientifique.

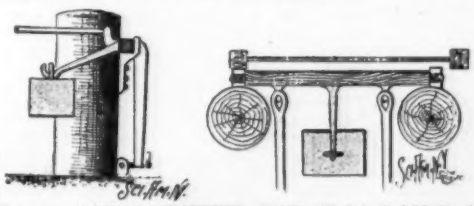


FIG. 7.—ARRANGEMENT FOR HOLDING A LARGE VESSEL IN PLACE—VERTICAL AND HORIZONTAL SECTION.

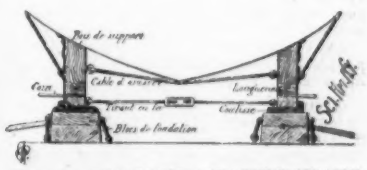


FIG. 9.—SECTION OF THE WAYS OF AN IRONCLAD.

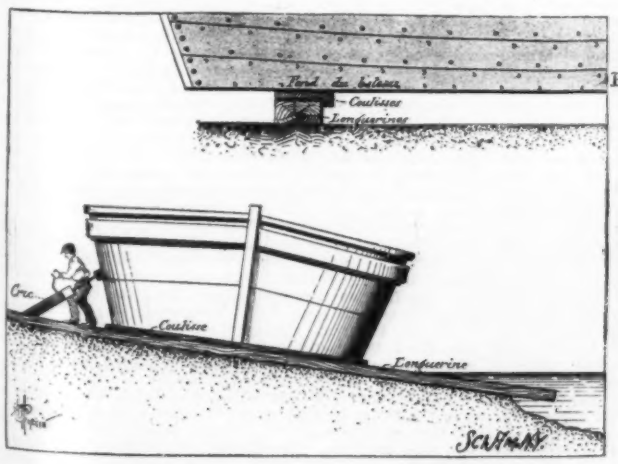


FIG. 1.—LAUNCHING OF A FLAT BOTTOMED BOAT.

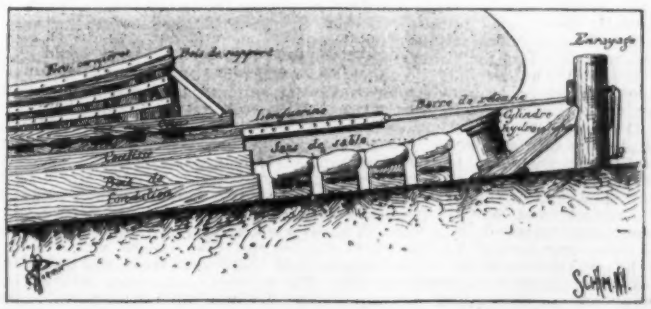


FIG. 10.—RAM AND PROW OF AN IRONCLAD READY FOR LAUNCHING.

ENGINEERING NOTES.

John Hardy, the inventor of the vacuum brake, died recently in Vienna, where he had been employed by the state railroads. He worked for a time under George Stephenson.

According to data of coal used in its crude state for firing stationary boilers, the efficiency of the steam engine worked by such boilers, in what is said to have been the most successful test recorded, corresponded to only thirteen and eight-tenths per cent. of the potential of the coal consumed; that is, in the Sibley test of the North Point pumping engine in Milwaukee, in March, 1893, and pronounced the best ever reported from any steam engine, thirteen and eight-tenths per cent. only of the potential of the coal was converted into work. In ordinary practice eleven per cent. is a high ratio in stationary engines. In locomotive engines the waste is very much greater, not exceeding five per cent. of the potential of the fuel being converted into the movement of the train, thus showing a disastrous loss.

Paris has had its first serious motor carriage accident. The Automobile Club had had a run to the Pavillon Henri IV at St. Germain. On the return, in going down the steep descent between St. Germain and Fort Marly, the leading carriage, in charge of the Comte de Deon, came to grief. In trying to steer between a heavily laden farmer's wagon and the steam tramway train that runs on the side of the road, the automobile carriage was turned suddenly, knocking off one of the front wheels and throwing out the nine occupants. A Paris lawyer had three ribs broken. M. Georges Berger, who was director-general of the 1889 Exposition, and another gentleman were badly bruised, while the rest got a severe shaking up.

Extremely high smokestacks on naval vessels, such as the Brooklyn has, must go. Ships to be built will not have these towering stacks, and those now on completed vessels will probably be cut down. There are few officers of the line who regard the high stacks with favor. They all prefer lower stacks having larger diameters. They say these are more in keeping with the general appearance of a vessel of war, whether battleship, cruiser or gunboat. In favor of high stacks is the argument advanced some time ago by Engineer-in-Chief Melville. This is that the higher the stack the greater the draught, and therefore the better the results in the matter of horse power and speed. It is claimed against this that but few merchant steamers employ the high stacks. Admiral Walker's board made no recommendation as to the height of naval smokestacks, but informally the majority agreed that smokestacks, such as the Brooklyn and Iowa have, shall not be put on the newer vessels.

A straw which points to the future development of a remarkable source of economy in freight railroad traffic is the utilization of the weight of the freight which is proposed on a new road in Northern Michigan, says the Journal of Electricity. The road runs from Lake Superior fifteen miles inland to the mines, and in this distance the total grade amounts to a rise of 800 feet. The freight will be almost entirely iron ore, which is brought down in special cars, which are returned empty to the mines. The cars will be run in trains of ten each, each train being supplied with an electric generator connected with the axles. The grade is such that the loaded cars run by their own weight, and the dynamos generate a current, which is taken off upon a trolley wire and used to haul the empty cars back. It is thought that the difference in weight of the loaded and empty cars will give power enough to overcome all leakage, friction, etc. The engineers are figuring on using the dynamos as motors on the return trip, and thus saving expensive machinery. The experiment will be awaited with interest.

If it be true of fine wire, as stated in Iron and often set forth in print, then gold is by no means the highest metallic standard of industrial value. At a meeting of the South Staffordshire Institute of Iron and Steel Works Managers, Thomas Morris pointed out that the Warrington wire manufacturer who presented him with various specimens of workmanship in that line got $4.32 per pound or $8,600 per ton for the article of drawn wire exhibited and so largely used in the construction of pianos and other musical and mechanical instruments. For pinion wire he got $21.60 per pound, or $43,200 per ton. It took 754 hairsprings to weigh an ounce of 437½ grains; it took 27,000,000 of them to weigh a ton, and taking one to be worth a cent and a half, the value of a ton of these apparently "cheap little things" runs up to over $400,000. The barbed instruments used by dentists for extracting nerves from the teeth were even more expensive, representing a rate of $2,150,000 per ton. A mile length of No. 19 size wire weighed only twenty-one pounds, and many of the ingots were twelve to fourteen hundredweight each, and, after allowing for all the waste, only fifty miles of wire could be got from one ingot.

A fast run was made over the Canada division of the Michigan Central on May 7, with a special train of three cars, the distance from Windsor to Fort Erie, 229·4 miles, being traversed in 3 hours, 34 minutes and 59 seconds, equal to 64·03 miles an hour. There was only one stop, that at St. Thomas, to change engines, 4 minutes, 40 seconds. Superintendent Morford deems it proper to allow, besides this, 15 minutes for time lost at railway crossings and in crossing the switches at the ends of double track, which would make the average speed from Windsor to Fort Erie 70·44 miles an hour. About two-thirds of the Canada division is single track. The fast train over the Lake Shore and Michigan Southern, on October 24 last, ran 181·5 miles, including stops, at 68·67 miles an hour; deducting stops, the rate was 69·67. The Lake Shore train ran 289·3 miles at 65·14 miles an hour, including stops, and at 66·68, deducting stops. In comparing this run with that of the Michigan Central, it is to be remembered that the Lake Shore road is double track all the way. The weight of the cars of the Michigan Central train was 115 tons, and those of the Lake Shore train weighed 152¼ tons. The Michigan Central train was hauled by ten-wheel engines, with 19 × 24 in. cylinders and 68 in. driving wheels. These engines were built at Schenectady in 1889. They carry a boiler pressure of 160 pounds per square inch, and the weight in working order is 128,500 pounds; weight on drivers, 96,300 pounds.—Railroad Gazette.

ELECTRICAL NOTES.

An X ray nickel-in-the-slot machine has been devised. It is reported to be a success.

Batteries of the Schafer-Heinemann system will be used for propelling the cars of the line Charlottenburg-Bahnhof-Thiergarten, near Berlin, Germany, says Uhland's Wochenschrift.

The Société d'Encouragement lately offered a prize of 2,000 francs for an incandescent lamp of 1 c. p., 100 volts, one-twentieth of an ampere. It found itself unable to make an award, but an encouragement of 1,000 francs has been given to MM. Javaux and Nysten, and a similar sum to M. Solignac.

A Brussels firm has just accepted a contract for the establishment of a telegraph system throughout Abyssinia. Each telegraph station is to be furnished with a telephone, and the more important are to be connected with the residence of Emperor Menelek, so as to enable him to keep, if not an eye, at any rate an ear upon his dusky subjects.

It is again announced that Dr. G. De Laval and Engineer Robsahm, of Stockholm, have obtained from the Swedish government a concession for the establishment of a company for the smelting of ores in electric furnaces on a large scale. The capital is to be 15,000,000 kroner ($4,020,000). Water power at Trollhattan is to be utilized, and all the De Laval patents for electric smelting are to be acquired.

Mr. Charles Bright has prepared for publication an exhaustive treatise on the subject of submarine telegraphy, the field of work to which, like his father, Sir Charles Bright, he has specially devoted himself. The treatment will be historical as well as scientific, while the political and financial aspects of submarine cables will also be discussed. Subscribers' names are now being received by Messrs. Crosby Lockwood & Son, who have undertaken to publish the work if sufficient support is secured.

Compared with other large European towns, says an exchange, London is easily at the head for the magnitude of its electrical supply. Paris, for instance, has only an equivalent of about 500,000 eight candle power lamps, as compared with the 1,200,000 lamps in London. Manchester and Liverpool have respectively about 92,000 and 54,000; Glasgow, 70,000; Edinburgh, 43,000; Dublin, 16,000; and Cardiff, 9,000. Of the total capital expended in the whole of the United Kingdom for supplying electricity, London has spent more than one-half.

The Paris Temps states that the manufacture of the submarine cable which is to be laid between Brest and New York has already been commenced and will be completed by next summer. The new line will be open either in the month of August or September, 1897. Our contemporary says that the new transatlantic cable, which will be nearly 6,000 kilometers long, will henceforth assure the independence and security of French telegraphic relations with the American continent. In consequence, the government has granted a subvention of 800,000 francs per annum for thirty years for the laying down and repair of the cable, which will be constructed and laid by exclusively French means, and will be under the control of the state.

In a recent communication to the Academie des Sciences, says the Electrical Engineer, M. L. Benoist described a simple improvement made by him in the gold leaf electroscope, with a view to an increase of its sensitiveness. M. Benoist merely employs three leaves in lieu of two. When the electroscope is charged the central leaf remains rigidly vertical, while the two outer ones diverge equally on either side of it. The sensitiveness of such an instrument is markedly greater than that of an ordinary two leaf electroscope, each of the outer leaves being repelled four times more powerfully by the central leaf than by the opposed leaf, so that the same divergence is obtained with a smaller charge, and that is so, although the charge is divided between three leaves. A simple calculation shows that for small angles the sensitiveness is something like 50 per cent. greater than that of a two leaf instrument, and a general formula shows that the relative sensitiveness increases as the angle of divergence becomes greater. In a two leaf electroscope the sensitiveness becomes zero at about 90 degrees from the vertical. With a three leaf apparatus the limiting angle is 120 degrees.

Various substances and mixtures have been proposed for replacing gutta percha as an insulating material for cables, but although many of them are effectual in other particulars, none have, so far, rivaled it in point of durability under prolonged exposure to the action of sea water, says the Engineering and Mining Journal. Paraffin alone is too brittle, but the plastic products of the incorporation of ozokerite with small quantities of caoutchouc form a medium which in insulating power and durability almost rival the latter substance in its pure state. The degree of insulation attained by Henly's cable, which is coated externally with ozokerite, is 5,000 megohms per knot. Nigrite, prepared by kneading together caoutchouc and the residue from the distillation of ozokerite, is far superior, both mechanically and as insulator, to gutta percha, and is less susceptible to heat than caoutchouc. The composition, consisting of a mixture of resin and heavy resin oils, used for the Brooks cable, has a high insulating power, several samples having indicated regularly 19,000 megohms per mile. Wray's composition, made from caoutchouc, silica, powdered alum and gutta percha, is largely used in climates too hot for gutta percha by itself, but is quickly attacked by sea water. Latterly attention has been directed to balata as a substitute for caoutchouc. This gum is obtained by tapping the balata tree, of which there are large forests in British Guiana and other parts of South America. There are two varieties, the red or "bullet tree," and the white or true balata; they grow to the height of 90 ft. to 100 ft., and can yield about 2¼ lb. of gum in a year without overtaxing their strength. The liquid gum soon hardens on the surface, which is then removed, and this continues till the whole has solidified. For insulating purposes balata gum is, says the Journal of the Society of Chemical Industry, inferior to caoutchouc, but it makes a good waterproofing material, and is highly suitable for driving belts.

MISCELLANEOUS NOTES.

Compressed food, which has proved a failure in our army, was found useful on the British expedition to Ashanti. The desiccated soup was not damaged by the climate.

Saké is the national beverage of Japan, and until recent years was the only fermented liquor known in that empire. It is obtained by the distillation of the best kinds of rice. In appearance it resembles very pale sherry, though its taste is somewhat acid. The best saké is white, but there are many varieties, and the poorer people of Japan have to content themselves with a turbid sort. A glass of saké is drunk at every function and ceremony of daily life; even all offerings to the gods at the religious festivals, whether great or small, include a cup of saké.

In an interesting review of American milling in the past year, the Milling World says: "There were 1,387 mills built in the United States in the year 1895. Of these 1,139 are mills to grind wheat, and the rest are corn, feed, meal, oatmeal, pearl barley, rye, hominy, grits, and other cereal plants. The burned mills number 382, which, subtracted from the 1,139 new mills, leave 857 mills as the net gain of the year. In 1894 the net addition was 670 mills. Taking into the account the enlargement of 585 existing mills in 1894, it appears that, in spite of all the adverse conditions, the past year was better than 1894, far better than 1893, and quite equal in the way of profits and development to 1892 and 1891."

The great reduction in the cost of producing aluminum, which has been brought about by the scientific study of the processes, has resulted in the application of aluminum in many ways hitherto hardly expected. A still wider use for this metal will doubtless be found if its price can be halved. One of the latest uses is the manufacture of printing plates out of aluminum to replace lithographic stones. The surface of the aluminum plate sucks in and holds fast the color like a lithographic stone. It is applicable for type printing, as well as artistic work and colored effects. Its elasticity allows the plate to be applicable to cylinder pressure. The weight of the aluminum plates in relation to that of stone is as 1–10, the price is as 1–50.

Nelson's Foudroyant has been refitted again at a cost, it is said, of $100,000, and will be exhibited at the principal British ports, going first, however, to the Kiel naval exhibition. The vessel is a splendid specimen of the great 80 gun line-of-battle ships. Her timbers are in good condition in spite of her 107 years. She was Nelson's flagship for only one year, the most disgraceful one in his career, when, under Lady Hamilton's influence, he encouraged and aided the atrocities committed by the Naples Bourbons. It was from the yardarm of the Foudroyant that Prince Caracciolo, admiral of the republican fleet, a prisoner of war, was hanged without a trial. It was on the quarter deck of the Foudroyant that Sir Ralph Abercromby died of his wounds, after defeating the French at Alexandria in 1801.

It is reported that another attempt to raft lumber is to be made by Capt. H. R. Robertson, who built and engineered the transport of the cigar-shaped lumber raft from Stella, Washington, to San Francisco, last year, after two failures in the same direction. He is now having timber felled for the building of three more rafts that will be put together next month and floated from Stella to San Francisco. They will be of uniform size, each 527 ft. long, 52 ft. wide and 30 ft. deep, drawing 20 ft. of water when floated and will each contain about 5,000,000 ft. of lumber, board measure. The lumber, which includes piling and spar timber, saw logs and long timber of every description, will be packed in a cradle constructed for the purpose. The raft, when ready to be towed, will resemble a cigar in shape, flattened on the upper side and tapering to a point at each end. When the logs are placed in the cradle, a large tow chain will be run through the center of the raft. To this will be connected other chains running herring-bone fashion every 12 ft., fastened to other chains surrounding and binding the logs together the same distance apart. The reported cost of getting the last raft to San Francisco was $1,650, and even at that figure, it is much cheaper than the present means of transportation. Vessel men do not take kindly to the idea, for several reasons, one of which is that if this method proves popular and successful, it will take from them their business. More potent than that, however, is the fact that the unsuccessful attempts at rafting leave a great quantity of logs and timbers floating on the ocean, endangering vessels.

Among the exhibitions that are now going on or which are about to take place in Europe within the next few weeks, and that are worthy of attention on the part of American tourists, says the New York Tribune, is the "Exposition du Theatre et de la Musique" at the Palais de l'Industrie, in the Champs Elysées, at Paris. In addition to theatrical properties of all sorts, from the wig and whiskers of the light comedian to the battle ax and coat of mail of the tragic hero, there will be on view examples of medieval playhouses and reproductions of the simple stages and primitive scenery used by the miracle actors of old at the Notre Dame and elsewhere. In Berlin an international exhibition of fashion will be thrown open to the public at the Palace of Industrial Art in the first days of September. The exhibits will include textile fabrics, dresses for men, women and children, toilet accessories of every description, jewelry, fashion papers and patterns, paintings, engravings, etc. An International Congress of Fashion will be held at Berlin simultaneously with the exhibition, which is a government affair, and indorsed by the ministers of commerce and chambers of commerce of a large number of foreign countries. Among the exhibitions already opened are the Russian National Exposition, at Nijni-Novgorod; the Hungarian National Fair, at Budapest, organized to commemorate the 1,000th anniversary of the foundation of the Magyar kingdom; and the Swiss National Exhibition, at Geneva, representing the whole of the arts and industries of the Helvetian Republic. Covering a large area, it is beautifully situated upon the plain of Plainpalais, near the point where the waters of the Arne flow into the Rhone, while the Jura range, the Savoy Alps and Mont Blanc provide it with an unrivaled background.

SELECTED FORMULÆ.

A Good Brazing Flux.—Probably for some kinds of work borax will never be improved upon for a flux, but for some other varieties of brazing borax does not completely fill the bill—as, for example, when brazing work which must be filed and cannot be ground. Then the borax will leave a very hard skin, which destroys many a file before it is fully removed. For this kind of work some mechanics like to use boracic acid, putting it on with a brush or a swab. The hard skin is thinner, and comes off easier when the acid solution is used, but a writer in the Tradesman is of the opinion that the difference lies mostly in the fact that not so much of the flux is used when the solution is employed. The usual way is to pound up a lot of lump borax in a lead melter's ladle or the hollow of a blacksmith's sow. Some of this (usually very coarse) powder is placed on the work with a bit of flat iron. Too much borax for the purpose is necessarily used in this manner, and the excess goes to make up the hard skin which "does for" the files. When the acid is used the same effect is secured as when the solid borax is applied, but not one-tenth the amount is used, and that is applied just where it is needed. If, for any reason, the manager insists upon solid borax being used, make that official procure a coffee mill (one of the old fashioned cheap ones will answer perfectly) and have all the borax ground very fine. Then a little of the dust powder can be rubbed or dusted on where the joint is to be made, and the braze made without having a lot of oxide and slag piled up around the work.—Railway Review.

New Method to Distinguish Sugars.—A. Villiers and Fayolle (Pharm. Zeitsch. f. Russl., xxxv, p. 48) state that a solution of rosaniline, which has been decolorized by a very small quantity of sulphurous acid, again becomes colored on the addition of aldehydes, but remains colorless when treated with ketones. A few sugars—such as grape sugar, invert sugar, galactose, and the reducing dextrins—behave like aldehydes; while others—such as levulose and sorbin—act like ketones. It is in this way possible, the authors state, to determine whether a certain sugar partakes of the nature of an aldehyde or of a ketone. Only concentrated neutral sugar solutions must be used, since acids interfere with the rosaniline reaction, and the sugars employed must be entirely pure. Cane sugar, maltose and lactose give at first no coloration; but, if they remain in contact with the decolorized rosaniline solution for a few days, the red coloration develops and gradually increases in intensity. These sugars seem to be inverted on standing, and then form sugars having the nature of aldehydes which are capable of restoring the color of the decolorized rosaniline solution.

House or Household Ammonia.—

I.

Ivory soap (or other good white soap).4 ounces.
Rain water ... .4 pints.
16° ammonia water... .....4 "

Cut or shave the soap fine and dissolve it in the water by the aid of heat, then cool and add the ammonia. If other strength of ammonia water is used, make it to correspond with the 16°, for example, if the U. S. 10° is used, take only 2 pints of water instead of 4 pints, and use 6 pints of ammonia water; if 20° ammonia is used, use 5 pints of water and 3 pints of ammonia water. This is sometimes called "White Ammonia."

II.

Potassium carbonate. .. ..1 ounce.
Rain water... ....4 pints.
Ammonia water..... .....4 "

Dissolve the potassium carbonate (sal tartar) in the water and add the ammonia water.

III.

Concentrated lye or potash.....1 ounce.
Resin water.....4 pints.
Ammonia water.... .. ..4 "

Dissolve the concentrated lye or potash in the water and add the ammonia. The ordinary concentrated lye that comes in cans, or Babbitt's potash, may be used.—The Formulary.

Imperial Cloth and Glove Cleaner.—
For silks, dress goods and fine fabrics, ribbons, gloves, etc.:

Wood alcohol.... ..... 1 gallon.
Ether.....1 ounce.
Chloroform..... ..... 1 "
Oil of bergamot..... 1 drachm.
Essential oil of almonds ....10 drops.

Mix them. To be applied with a sponge or soft cloth. This is more expensive than the former, but is very effective.

Potassium Chloroplatinite.—This is rather a troublesome salt to make. Dissolve 50 grammes of platinic chloride in 100 c. c. of distilled water, heat to 100° C., and pass a stream of washed sulphurous acid through it till it no longer gives a precipitate with ammonium chloride, allow to stand twenty-four hours, and add hot a solution of 23 grammes in 50 c. c. of water, stir, allow to cool, wash and dry crystals. Or place in a glass 24 grammes potassium platinic chloride and 300 c. c. water, 12 grammes potassium acid sulphite and 12 grammes potassium chloride, bring to the boil, and allow to boil twenty-five minutes, then allow to cool and pour out into flat dish to crystallize, which takes about two days.—Pharmaceutical Journal.

Acid Phosphate Solution.—
The following formula is said to yield a good article:

Phosphoric acid, 50 per cent..... 64 parts.
Precipitated chalk..... 12 "
Calcined magnesia ..... 1 "
Potassium carbonate..... 1 "
Distilled water.....178 "

Add the chalk to the acid gradually, and then add the magnesia and stir well. Dissolve the potassium carbonate in 9 fl. oz. of the water, add the solution gradually to the acid liquor, admix the remainder of the water, set aside for one or two hours, and filter.—South. Jour. of Phar.

THE LUGANO ELECTRIC TRAMWAY.

A FEW weeks ago we gave some details of the three-phase system employed on the Lugano electric tramways, says the English Electrical Review. We are able to supplement the information given then by the following account taken mainly from the columns of the Elektrotechnische Zeitschrift.

The employment of the three-phase motors on the cars necessitates two trolley poles and two overhead wires.

It is unnecessary to say much about the advantages that accrue from using this somewhat complicated system; no doubt it offers an easy solution of the problem of transmitting electrical energy to considerable distances, and experience has shown that three-phase motors are reliable, while their simplicity is, of course, their most important characteristic. For the purpose

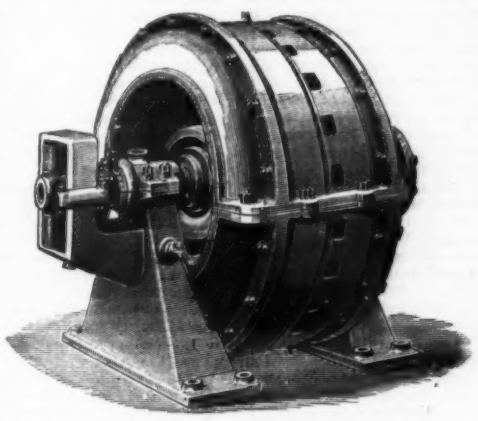


FIG. 1.—LUGANO ELECTRIC TRAMWAY.

of regulating the speed of polyphased motors, resistances are placed in the armature, which provides one of the simplest methods of regulation.

Owing to the conditions that were attached to the scheme, Messrs. Brown, Boveri & Company adopted the three-phase system.

Some twelve kilometers from Lugano, in a place called Maroggia, Messrs. Bucher & Durrer own a waterworks plant from which electric light is and has been furnished to the town of Lugano for several years by means of ordinary alternating current. It was intended to use this water power for operating a railway at Lugano and, besides, to deliver power to the railway of the Mountain San Salvatore and to some factories. The railway will afford an easy communication between the suburbs, in which and in the city are many hotels and cottages. From these data it can be seen evidently that a direct application of continuous current of 500 to 600 volts from Maroggia was out of the question. Moreover, a transformer station would have been too expensive, and would involve too great losses. The project, therefore, involved conditions which could be solved satisfactorily only by direct application of polyphased currents.

In Maroggia, a high pressure turbine made by the firm of Bell & Company, of Kriens, of 300 horse power, with horizontal axle, has been erected, and by means of an elastic coupling connected to a 150 horse power three-phased generator. The number of revolutions is 600 per minute, the voltage 5,000, and the periodicity 40. The generator, shown in Fig. 1, has a stationary armature, and only the iron parts of the field magnets revolve. Unlike the usual arrangement of such machines, the rotating poles are not opposite each other, but the pole shoes on the one side are opposite the pole openings on the other. This arrangement gives the special advantage that the armature coils for both halves of the armature are common; that is to say, the armature winding goes directly through both halves of the armature, and each half does not have a separate winding. The armature wires are threaded through holes, and are separated from the iron by heavy insulating tubes.

The exciter is combined with the generator and the commutator is on the side toward the bearing.

The line to Lugano consists of three 5 millimeter copper wires, and for the present there is in Lugano only one transformer station about in the middle of the railway net. Later on, when more cars are on the line, other transformers will be installed at other points. The transformers reduce the pressure to 400 volts. The total length of the road is 4,900 meters, and on its whole extent are grades up to 30 per cent. over long distances, and on three very short distances 60 per cent. The two overhead wires are 6 millimeters in diameter, and are placed at a distance of 25 centimeters from each other. The rail bonds are made of copper wire, well riveted; a separate ground return wire is not used.

For the present four carriages of the new design have been provided, supplied by the Herbrandt Works at Koln-Ehrenfeld, each holding 24 persons. Each carriage has only one motor of 20 horse power, which, by means of a simple tooth wheel arrangement, drives one of the axles with a transfer proportion of 1:4. The traveling speed is 15 kilometers per hour. On the carriage are fixed two separate trolley arms, the same being about 1 meter behind each other. The motor is in separate casing of cast metal, so that it is secured against dust and damp. The current is taken by three sliding rings from the induced and, in this case, revolving part of the motor, and conveyed to the regulating apparatus and the regulating resistance, Fig. 2. In order to control the interior of the motor, there is above an opening which can be hermetically closed by a cover. The carriage can be set in motion and regulated

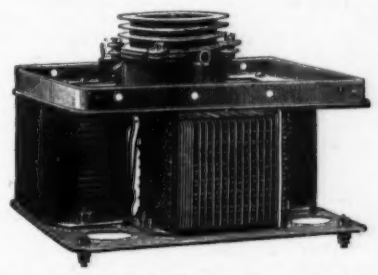
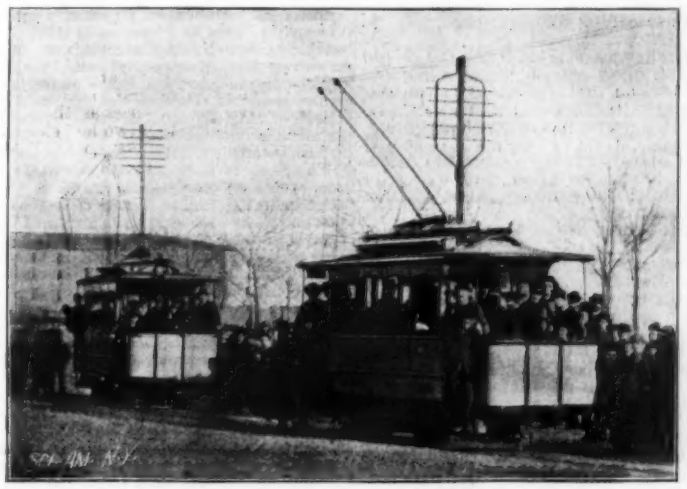


FIG. 2.—LUGANO ELECTRIC TRAMWAY.

from both platforms. To the right of the driver is the handle of the hand brake, and on left the regulating lever, by means of which the carriage can be set in motion and stopped with any desired rapidity, i. e., between stoppage and 15 kilos. On the lower left side there is also a switch, which serves for a change of direction, and at the same time for the total interruption of the current. As already mentioned, the task which devolves upon the driver for regulating the speed is exceedingly simple. In most cases the driver has merely to set the regulating lever to the full number of rotations, when the carriage moves with a constant velocity, either up hill or down hill.

In cases where the lines lead far outside the cities, and consequently a greater speed is admissible and desirable, the number of poles can be reduced by a special arrangement, when the velocity is correspondingly increased. The same effect may be also obtained by working in such cases with a higher number of periods. Where very exceptional gradients have to be overcome the performance of the motor may be considerably increased by altering the connections of the windings (increasing the density of the field). The increase of the working power of the motor may also be effected by providing parts of the line with current of a higher tension, which, in consequence of the simplicity of the transformers, can be easily effected. If we wish to ascend such gradients with a smaller consumption of power, we may feed such parts of the line with current of a lower periodicity.

The first trial trips on the Lugano line took place in December, 1895, and were in every respect satisfactory. As the line on its whole extent passes near telephone leads, it was to be expected that these leads would be influenced by the rotary current working. Experiments purposely undertaken have shown that the effect on the telephone currents can be completely annuled by metallic return leads, whence the management of the telephones agrees that the necessary work should be completed at once. At the steepest gradient, about 60 per 1,000, overloaded cars can ascend without any increase of the intensity of the motor being requisite.



LUGANO ELECTRIC TRAMWAY.

It is announced that the Erie Railroad Company has agreed to elevate its tracks in Jersey City between the Bergen Tunnel and the Hudson River. The work, which will cost about $1,000,000, is to commence next fall.

[Continued from SUPPLEMENT, No. 1079, page 17246.]

THE ART OF BRONZE CASTING IN EUROPE.*

By GEORGE SIMONDS.

IN strong contrast to this work is the well known equestrian statue of Marcus Aurelius, remarkable above all else as being, I believe, the only statue of an emperor which, from the time of its erection to the present day, has always been respected and carefully preserved by the Roman people. There is, I believe, nothing known as to its authorship, and we can only guess, from a certain heaviness and from its general style, that it is probably the work of a Roman artist or, at least, of a very Romanized Greek. This, at least, is the opinion of Perkins, and I must say that it is also my own. I am quite unable to find any signs of Greek feeling in it, and although it is undoubtedly, in many respects, a noble and impressive work, yet I must certainly protest against its being considered, as it has been by some writers and many readers, to be the finest equestrian statue in the world. Winckelmann, who seems to have a natural gift for mistakes of this sort, supposes this monument to have been of beaten plate, and this story has often been repeated. It is, however, nothing of the sort, but it is a waste wax bronze casting—not, however, cast at one pouring, but in separate pieces, as I have stated was usual among the ancients.

It would be too long, and indeed foreign to our present purpose, to trace the decline of the art of the statuary in bronze through the various ages of the decline of the Roman power down to the final destruction of the last refuge of art by the siege and sack of Constantinople in the thirteenth century. There are, however, two bronze statues that I may mention as belonging to this period of decadence, one of which is supposed to represent either the Emperor Heraclius or Erico, King of Lombardy; it stands in the piazza of the town of Barletta. According to tradition, this statue was cast at Constantinople by a Byzantine artist named Polyphobus, about the middle of the seventh century. Perkins, however, considers it to be a genuine Italian work, and believes it to be of earlier date. I have never seen this statue myself, nor any photograph of it, but as Perkins was a most excellent judge of sculpture, he is probably correct in his estimate. The other is the well-known statue in bronze of St. Peter, in the basilica of St. Peter's at Rome. This statue is said to have been cast by order of Pope Leo I, as a thank offering to the saint for his interposition and deliverance of the city of Rome from Attila. The date assigned to this statue is A. D. 153. There is a legend that it is an antique, and was a statue of Jupiter, and that the head and hands only are of Christian origin. There is, however, no evidence of this, and, on the contrary, plenty of internal evidence that the work is of one period, and that not classic. Possibly an antique Jupiter may have been melted down for the sake of the metal, and as a further honor to St. Peter by the destruction of a pagan divinity.

The period from the fifth to the ninth century gives us no record of any Roman artist, and we may easily understand that the iconoclastic war and wholesale destruction of statues, which was so vigorously prosecuted by Leo the Isaurian and his son in the eighth century, must have given the coup de grace to the already dying art of the statue founder; nevertheless the persecution of artists, and the consequent emigration of numbers of them from Byzantium, was the means of spreading such tradition of the art as might have survived into other and far distant lands, and the affiliation of numbers of these emigrants to the society or craft of the Comacine builders was the means of bringing a knowledge of the principles of the art into France, Germany, and possibly into England also.

During the ninth and tenth centuries sculpture seems to have been at its lowest ebb. In the eleventh and twelfth centuries, however, the art began to receive some consideration, and artists, it is said, were sufficiently proud of their calling to begin once more to sign their works.

In the twelfth century we once more find the bronze founder to the front. Borisanno of Trani, Simone di Ragusa, Bonanno of Pisa, and Jacopo of Innsbruck, were all busy as builders, carvers, and bronze founders, and cast bronze gates for several of the religious buildings of Italy and Sicily.

In the thirteenth century again we have the names not only of foreign, but also I am glad to say of English artist founders; unfortunately most of their works have been destroyed.

There are records of statuettes in bronze and also in silver by Simon of Wells, A. D. 1257, and by William of Gloucester, about the same date. A few years later, in 1281, we have the statue of Henry III, followed in 1290 by that of Eleanor of Castile, both by William Torell, or Turell, who was a sculptor goldsmith and a citizen of London. At the close of the fourteenth century we had Nicholas Broker and Godfrey Prest, who, in 1397, erected the statues of Richard II and of Anne of Bohemia, both on one tomb in Westminster Abbey.

It is perhaps not uninstructive to note by the erection of bronzes in Westminster Abbey the fluctuating fortunes of the art. Thus in the thirteenth century we have recorded the erection of 6 works; fourteenth century, 12; fifteenth century, 10; sixteenth century, 9; seventeenth century, 6; eighteenth century, 2; nineteenth century, 6; total, 51 works. The above list begins with the year 1246, monument to Abbot Berkyng, and ends in 1887, Mr. Alfred Gilbert's monument to Mr. Fawcet. Of these 51 bronzes many are no longer extant, and others are not strictly speaking bronze, but are incised work, generally known as "brasses."

For the present I shall only speak of the bronzes by Torell, Broker and Prest. The earlier ones, those by Torell, are most interesting works, and as examples of early English statue founding invaluable. They are cast in one piece and are enormously thick, almost solid. A few years ago, when some repairs were required to the stonework, I had an opportunity of examining the under side, which showed a shallow depression with a rough surface. It looked as if the metal had been poured into an open mould and that some sort of core heavily weighted had been pressed down upon the molten metal so as to force it to rise to the exact level of the edge of the mould, or as if while the metal was still fluid or partially so a portion had been scooped out.

I have been much puzzled to guess how the models for these figures were produced, and whether the wax process was employed. On the whole, I incline to the belief that the models were carved in wood, without any undercutting, and that any necessary projections were fashioned in wax and attached to the wood models. After the completion of the mould the wax could be melted, and the wooden pattern easily withdrawn. A process on this principle was used for casting cannon and bells. I am certain that these statues were cast in one piece, and unless some modification of the wax process was used, we must conclude them to have been piece-moulded, which I think most improbable.

The other two statues, of Richard II and of Anne of Bohemia, show us what progress had been made during the past century. These statues, by Broker and by Prest, were probably cast in 1397. They are fine works of art and excellent castings. They are properly cored, and, although the casting is rather heavy and thick, it is not excessively so.

I have no doubt as to the process here employed. I believe the statues to have been modeled in loam, which was then dried and pared down to form a core. This was then overlaid with a suitable thickness of wax, to represent the bronze statue, and was finished to whatever degree the artist thought requisite. The whole was then moulded in loam and the wax burned out.

There is one more point to be noticed, that is, that in these statues the hands were cast separately, whereas in those by Torell they are in one piece. This may be accounted for by another reason than the difficulty of moulding, for the hands of Richard and Anne were clasped, but some thief stole them. The hands were probably added after the statues were finished and placed in position. None of these works are left from the mould, but are chased over, and richly gilt.

About a century later William Austen cast in bronze a statue of the Earl of Warwick, still extant.

A few years after Torell had completed his statues in Westminster, Andrea Pisano, one of the most noted of the Italian bronze founders, was born, and in 1330 he completed the models of his chief masterpiece, the bronze gates of the Baptistry at Florence. The casting of these works occupied him for nine years more.

It would be tedious to quote a long list of more or less able founders and their works through all the years of the Italian revival. It will be enough to mention a few of the best known among them, as Ghiberti, Donatello, Michael Angelo Buonarotti, John of Bologna, Benvenuto Cellini, etc.

Of Ghiberti, it is sufficient to say that he was a most famous and successful founder. The bronze gates which he made for the Baptistry at Florence are a lasting monument to his fame. Besides these, he modeled and cast the statues of St. John and St. Matthew for the church of Or San Michaele. The baptistry gates occupied him for nearly fifty years; they were begun in 1403, and the second gate was not finished until about three years before his death in 1455. The wax process was employed for these, as for all early Italian bronze work.

Donatello, born about five years later than Ghiberti, was his only rival in the bronze founders' art of that day. For the sake of brevity, I shall only mention a few of his works: The group of "Judith and Holofernes," which stands in the Loggia dei Lanzi, at Florence; the "David with the head of Goliath," in the Museo Nazionale, at Florence; and the colossal equestrian statue of Gattamalata, at Padua. This statue, which, although a very fine work, is decidedly inferior to another similar one by Verocchio, seems to have given him much trouble; it was executed between the years 1451 and 1456. At first he began to make a full sized model of the horse in wood, but he abandoned that plan, and the incomplete wooden model is still to be seen at Padua. It is probable that the work was finally carried out in wax over a loam core, and that the casting was made in several pieces. In 1456 he returned to Florence, where he died ten years later.

The most celebrated pupil of Donatello was Andrea Verocchio, born at Florence in 1432. He executed many works, of which but few remain to us. All that he did in silver has disappeared, and we have only a few bronzes, among which is the charming fountain in the courtyard of the Palazzo Vecchio, and the incomparable statue of Bartolomeo Colleone, at Venice. Apart from its merit as a work of art, the history of this statue is full of interest.

The Signory of Venice do not seem to have behaved very well to Verocchio, at least in the beginning, for after bringing him to Venice to execute this statue they seem to have wished to have his pupil Vallano, of Padua, joined with him in the work. Verocchio not unreasonably considering this as a slight on the part of his employers, broke up the head and legs of the horse on which he had been working and fled to Florence. On this the Signory, unable to lay hands on him, published a decree banishing him forever from Venetian territory under pain of death. Verocchio replied that he would certainly never return, since if they were foolish enough to cut off his head they could neither put it on again nor get another as good, but that he could at any time make a new and a better head for his horse. The Venetians came to the conclusion that he was right about this, for shortly afterward they rescinded their hasty decree and recalled Verocchio, doubling his pay, and promising that his work should in no way be interfered with. Unfortunately he did not live to complete it, and at his request the Signory intrusted his pupil, Leopardi, with the task of bringing the work to a conclusion.

It has never been known, and probably never will be known, how much of the work was finished at Verocchio's death. In his will he speaks of it as Opus equi per me principiati, making no mention of the rider, from which Perkins concludes, I think rather hastily, that he had very little to do with it except as design. Had Perkins been more familiar with the insides of sculptors' studios and foundries, and above all with the colloquial Italian, he would have known that nothing is more usual than for an equestrian statue to be spoken of as "Il Cavallo." I have frequently heard my own Italian assistants in London so speak of the statue of the Duke of Wellington, although there was certainly no doubt about the duke being on the horse's back. In any case it is believed that Leopardi cast the statue and made the pedestal. Verocchio began the horse in 1479 and died in 1488.

We have now reached a period in the history of European bronze casting when the art was so well understood and so widely diffused that it is quite impossible for me at present to give anything like a complete list of names, and to do more would require a volume which I have neither the ability nor the leisure to undertake.

Leonardo da Vinci and Michael Angelo were both engaged on works of the highest order, and although we have no bronze statue left to us by the former, we have much information concerning his great work, the equestrian statue of Francisco Sforza, the sketches and notes concerning which are preserved in the Royal Library at Windsor. We know that for this work he made no less than fourteen designs, and two full-sized models, the first of which did not please him, and the second was never cast, for, although it is beyond doubt that the model was nearly if not entirely finished, Leonardo was busy at the same time with the fresco of the "Last Supper," and, consequently, put off casting the statue until it was too late. In 1499, Ludovico Sforza was overthrown by Louis XII, who permitted his soldiers wantonly to destroy the model.

Some have thought that the bronze group of "St. John and the Doctors," over the door of the baptistry at Florence, was in part at least his work, but there seems to be but little doubt that it is entirely the work of his friend Rustici.

Michael Angelo himself was also a bronze founder, and once, at least, an unfortunate one, since we find in his letters bitter complaints of his want of success in casting the statue of Pope Julius at Bologna, which he ascribes to his having too confidently intrusted the conduct of the process to a cannon founder instead of attending to it himself. He amended this error, and the second time he cast it successfully in the year 1508. Three years later it was destroyed by the populace, and melted down to cast cannon.

Of this greatest of sculptors I need say no more, but pass on at once to the lesser men—Torregiano, born 1472, and Rovezzano, probably about the same time. Both of these artists came to England, and were engaged, the former on the tomb of Henry VII and the latter on the tomb which Cardinal Wolsey had ordered for himself. This tomb was never finished, and all the bronze work about it was melted down by the Commonwealth, after the execution of Charles I. The sarcophagus alone was left, and was, it is said, used to receive the body of Lord Nelson. Considerably younger than these men, having been born 1500, Benvenuto Cellini, the artist, whose name is most familiar to us all as a bronze founder, appears on the scene, and after this time, the accumulations of experience in this art were apparently first reduced to writing; at least, I have found no earlier treatise on bronze casting than a work entitled "Pirotecnica in dieci Libri," which contains, among other matter, some information on casting. It was published at Venice in 1558. Besides this, there is a most admirable little work by Cellini, called "Due Trattate," etc., published in Florence in 1568, which consists of a series of most admirably written articles on the various processes employed by himself in his profession. This work, which, strange to say, is almost unknown, is of far greater technical value than his autobiography, which contains but little technical information of importance, yet his life has been through many editions, and has been translated into many languages, while the "Due Trattate" was, as far as I know, never reprinted until 1852, when a very poor edition was published at Milan. Some years ago I was so fortunate as to obtain a perfect copy of the first edition, and my wife undertook, at my request, the very difficult work of an English translation. This is now finished, and I hope that before long I may be able to arrange for its publication.

About the year 1540, Cellini went to Paris, where he spent five years executing many important works in silver and one in bronze, a relievo known as "The Nymph of Fontainebleau." In the "Due Trattate" the method of casting this work is described with much detail. The silver statues were all melted down a few years later. On his return to Florence, he was fortunate enough to receive a commission from Duke Cosimo, in 1545, to model and cast in bronze a statue of Perseus, to be placed in the Loggia dei Lanzi. This work he finished in 1548, casting it in two parts, one being the base with the body of Medusa, and the other the statue of Perseus himself. One of the feet of Perseus did not come, and was added afterward. It is interesting to know that, about three hundred years later, Clemente Papi, of Florence, made a replica of this celebrated group in bronze at one single casting, which was entirely successful.

Of the other Florentine bronze founders of that period, we need only mention John of Bologna, who, in truth, was not a Florentine, but a native of Flanders, said to have been born in 1530, Perkins thinks probably some years later. Among other works in bronze he cast a colossal Neptune for the fountain at Bologna, and some years later the flying Mercury, the Grand Duke Cosimo in the Piazza della Signoria, and the equestrian statue in the Piazza della Annunziata, both at Florence. This last is a very inferior work, and it is believed that John of Bologna had little hand in it. It was cast by his pupil, Pietro Tacca, who probably also did most of the modeling. John of Bologna died in 1608.

The erection of equestrian statues was coming into fashion, not only in Italy, but in France and other countries. In 1604, an equestrian statue of Henri IV was commissioned of John of Bologna, but it was not finished before the death of the artist and the assassination of the king. It was, however, finished and cast in bronze at Florence, I know not by whom, probably by Tacca, and was transported to Paris and erected on the Pont Neuf in 1616. The next equestrian statue that I have any note of is one of Louis XIII. It stood in the Place Royal, and was erected in 1639. The horse was by Daniele di Volterra, and was intended for a statue of Henri II, but the artist dying in 1556, he could not complete the figure of the king. It was afterward utilized for the statue of Louis XIII, the figure being completed by a sculptor named Biard. I have never seen a representation of this work.

(To be continued.)

* Lecture before the Society of Arts, from the Journal of the Society.

The electric tramway in Cairo, the first constructed in Egypt, has just been successfully inaugurated by a trial trip in the presence of Fahkry Pasha, minister of public works, and a large number of spectators.

A COMPLETED CHAPTER IN THE HISTORY OF THE ATOMIC THEORY.*

THE great discovery of the law of gravitation was left reasonably complete by its author. The explanation of this fact is obvious. No other force of sensible magnitude complicates the action of gravitation; its law appeals to simple geometrical relations; and the facts had been well observed and reduced to order. Accordingly, by a few numerical comparisons of the hypothesis with the facts, Newton established the truth of his conjecture so that it has been generally accepted as a law of nature. The first suggestion of the theory was quickly followed by its final triumph.

Very different has been the history of the discovery which most chemists regard as next in importance to that of Newton. The discovery that matter consists of an aggregation of infinitesimal units or individuals was made by Dalton; but the first suggestion of this kind had been made at least twenty-two centuries before Dalton. Leucippus and Democritus were the earliest recorded believers in this doctrine; Epicurus adopted it; Lucretius expounded it in strains of noble eloquence. But all the early suggestions were quite barren and unfruitful for the advancement of science, for no one before the present century was in a position to make any verifiable hypothesis; and science grows by means of hypotheses so closely in touch with facts as to be verifiable. In later times Leibnitz accepted the notion of a certain kind of atomic structure of matter; Newton accepted and reasoned soundly upon a view which Dalton recognized as akin to his own. Kant seems to have adopted the contrary opinion, and to have believed that matter is infinitely divisible. But Bernouilli made the conjecture, which has since been verified, that a given volume of gas consists of a very large number of very small discrete particles, which we now call molecules; and Higgins, an English chemist, a contemporary of Dalton, was the first to apply the notion of atoms to the explanation of chemical phenomena, although he did not think clearly in regard to the weight of atoms, and so formed no useful hypothesis. Accordingly the net result of twenty-two centuries of thought on this subject was to form a conception of a possible structure of matter without imagining any way of establishing the truth or error of this conception, or even of gaining any evidence whatever in regard to it. But if any are inclined to visit this failure with reproach, it is interesting to notice that the first man who was aware of the quantitative relations which are adapted to throw light on the matter did not fail to make the most full and complete use of this knowledge.

Dalton, and not the ancients, ought to be regarded as the discoverer of the atomic structure of matter, because he invented a hypothesis involving such a structure which was capable of being so compared with facts as to be proved or contradicted; because he actually began such a comparison of the hypothesis with the facts, and because all the evidence from facts, varied as it has since become, supports the hypothesis substantially in the form which he gave it. He who suggests that a certain benefit is desirable, or who conjectures that it is possible, shall not fail of due credit; but he who confers the benefit will receive the credit due the benefactor.

Since Dalton's discovery much has been done to confirm and enlarge our knowledge of the atomic structure of matter. New evidence has been acquired in favor of it, because the theory has been ready to extend over whole realms of facts of a kind unknown to Dalton, to explain them, to facilitate their study; and also ready to predict facts, unknown till they were sought in consequence of the prediction, but found when they were sought.

The history of the atomic theory for ninety years would fall into several distinct chapters. One of these chapters—not the least interesting of them—would tell of a very large amount of work, some of it of consummate accuracy, of which the object was to attain some knowledge of the nature or construction of atoms. Since the last meeting of our association in this city work has been accomplished which, if I rightly judge, has ended this particular chapter. That the chapter may at some future time be resumed is, of course, not absolutely impossible; but for the present it has come to a definite close. My own interest in the matter suggests, and the coincidence in time now mentioned perhaps justifies, my selection of this completed chapter in the history of the atomic theory as the subject of the address which our constitution requires of me this evening.

This chapter naturally concerns more intimately the members of the sections of physics and chemistry. To these I can hardly hope to say anything not already well known to them; but members of other sections may, perhaps, not be entirely uninterested in an account of the conclusions reached.

Dalton's theory was founded on three facts. These facts are often called Dalton's laws; one of them, because he discovered it, the others because he first recognized their important relations to chemical theory. One of these is the law of definite proportions: in any chemical compound, the ratio of the components is constant, is invariable, is definite. This truth had been recognized by others; it was finally established as a result of the discussion between Berthollet and Prout; a discussion well worth recalling for the dignified courtesy and simple love for truth shown by both the disputants. A second of these laws of Dalton is the law of equivalent proportions: if two elements, which combine with each other, combine also with a third, then the ratio in which they combine with each other (or a simple multiple of it) is also the ratio of the quantities of those which combine with the same quantity of the third. That this was true, at least in some cases, was known before Dalton. The third law is the law of multiple proportions: if two bodies combine in more than one ratio, those ratios are simple multiples of each other. This truth was discovered by Dalton.

These three laws are statements of facts. Careful and multiplied experiments have convinced us that, if these statements are not rigorously exact, their deviation from accuracy is less than the accidental errors of the best experiments used to test them.

Perhaps it is worth while to delay for a moment, in order to state to what degree of precision such experiments have been brought. The degree of precision with which any supposed law can be verified depends on the skill of the investigator, on the instrumental equipment available, and on the conditions of the problem. Often the conditions of the problem impose very stringent limitations on the precision of our experiments. For instance, the truth known as Ohm's law has been verified, in the case of metallic conductors, to one part in a million millions; but in the case of liquid conductors, the conditions are such that the precision attainable so far has been only a millionth as much. Huyghens' law, relating to double refraction, has been verified to one part in half a million, and there seems to be no possibility of attaining any considerable increase in the precision of the observations. These are examples of the very highest degree of precision which has been secured in the verification of supposed laws of nature.

The precision which can be attained in chemical analysis, even of the most elaborate kind, is much less than in the cases just mentioned. The determination of atomic weights is the chemical process in which the highest degree of precision is demanded. If we denote the precision of such determinations by the words "good," "excellent," "admirable," "consummate," then we may fairly say that in a good series of determinations the average difference from the mean of all will be less than one thousandth part of the ratio sought; in an excellent series, less than one three-thousandth part; in an admirable series, less than one ten-thousandth part; and in a consummate series, less than one fifty-thousandth part.

Now the work of Stas was all admirable in precision, and much of it was consummate, and he made experiments expressly intended to verify the law of definite proportions. The average error in this series of experiments was not more than one part in thirty thousand: and his result was, that if the composition of the compounds examined is not rigorously constant, the variations are too small to be detected. The law of equivalent proportions was verified with the same degree of precision; the accuracy of the law of multiple proportions has been thought to be deducible from the truth of the two other laws.

To some such degree of precision, then, Dalton's laws are the expression of facts. With these facts for a guide, and with no theory founded on the facts and explaining the facts, all chemical computations could be made, and chemical formulæ could be established. And, if a theory should be devised and accepted, and finally overthrown, these facts would remain, unchanged, for our perpetual guidance. Some of Dalton's contemporaries accepted the facts as a sufficient guide, and refused to burden them with the weight of the theory. Some were engrossed, for the time, in following out practical consequences of the facts; some distrusted conclusions supported by but a single line of evidence; some, perhaps, distrusted the capacities of the human mind. But the facts were accepted.

All scientific men, all sensible men, have a great respect for facts. Perhaps one cannot have too great a respect for facts; but his respect may be wrongly directed. Facts are often very interesting in themselves; they often have an important relation to human welfare; their discovery is often a great intellectual triumph: and we may regard them as the miser regards his gold, forgetting that the most precious use of facts is to help us to see beyond them. Facts are evidence; but we seek a verdict. Facts are a telescope; we desire enlargement of vision, further insight into nature. Facts are openings which we laboriously hew in the walls which shut us in: they cost enough to be valuable, but their real value is in that which they promise or disclose. Facts are a foundation for our building; the structure must rigorously respect the lines of the foundation; but it is a pity to believe that the basement walls are the chief beauty desired by the architect or owner. As Tyndall phrased it in a lecture at Manchester, "Out of experience in science, there always grows something finer than mere experience. Experience, in fact, only furnishes the soil for plants of higher growth."

In the present case the soil was fertile, the finer growth has been rapid and vigorous. Dalton inferred that chemical elements consist of very small units or individuals; that all the units or individuals of any given element are equal in weight; and that combination takes place by the grouping together of different units or individuals. This is Dalton's atomic theory.

In Dalton's time there was no fact opposed to this novel conclusion; but there was no second set of facts to support it. The progress of chemistry depended on making due use of Dalton's three laws, and they were quickly and generally accepted; but whether the hypothetical chemical units or individuals actually exist or not, although a most interesting question, did not press for instant decision. Most chemists regarded with favor the idea of the actual existence of the chemical units or individuals. Dalton called them atoms, and perhaps the name brought misfortune; for many thought that the new theory was, that matter is made up of units or individuals which cannot be divided by any possible force. The word "atom," the word "indivisible," like the word "individual," properly mean that which is not divided in the phenomena considered. An absolutely indivisible atom, like an irresistible wave or an immovable rock, can be spoken of to puzzle children; but for adults, as Clifford said, "If there is anything which cannot be divided, we cannot know it, because we know nothing about possibilities and impossibilities; only about what has or has not taken place." I judge that many, probably most, chemists and physicists understand the word "atom" correctly; many others understand it to mean that which cannot be divided by any possible force, and so misunderstand it. For instance, the author of the "History of the Inductive Sciences" failed to understand the word as chemists and physicists understand it, and so supposed that he rejected the atomic theory. Many chemists would reject the theory that matter consists of very small units which cannot be divided: I suppose that very nearly all believe that matter is made up of small units which are not divided in any chemical or physical change yet observed. This is the atomic theory of Dalton.

A few years after Dalton had formed the atomic theory, and had obtained the first experimental evidence on a matter which had enlisted attention for more than two thousand years, Davy showed, by brilliant experiments, that certain bodies were compounds, although they had resisted all previous attempts to decompose them. Since the first use of electricity had so important results, men were ready to suspect that even supposed elements might ultimately prove to be compounds. It was therefore in a congenial soil that Prout's hypothesis took root. Trusting to experiments of not much accuracy, Prout suggested, in the year 1815, that probably the atomic weights of other elements were divisible, without remainder, by the atomic weight of hydrogen; or, in other words, that they are whole numbers, if the atomic weight of hydrogen be taken as unity.

The new suggestion was most attractive, for two reasons. On the one hand, the truth of the new suggestion would lead to a very great practical advantage. The labor of determining atomic weights would be immensely simplified and lessened if we could know beforehand that the numbers to be found were integers. And, on the other hand, the new suggestion, if approved, would promise a most interesting and valuable hint as to the nature of matter and the structure of atoms. If, for instance, the atoms of carbon and nitrogen and oxygen weigh precisely as much as twelve and fourteen and sixteen atoms of hydrogen, then it is a very plausible hypothesis that each of these atoms is really composed of the material of twelve and fourteen and sixteen atoms of hydrogen, compacted into a new atom. Davy had led many to suspect that perhaps some atoms might be compound, and the new suggestion looking in the same direction was received with favor by many, among whom were great discoverers, and great experimenters, and great teachers of chemistry. In England, where Davy and Prout both lived, Thomson had great influence. It was Thomson who, in the Journal of Chemistry, of which he was the editor, first announced Dalton's discovery. Thomson wrote the history of chemistry. Thomson's "System of Chemistry" was thought worthy of translation into French at a time when French was the mother tongue of chemistry. And Thomson accepted Prout's hypothesis as probably true. But Turner made more accurate and more numerous determinations of atomic weights than any other English chemist; and he rejected Prout's hypothesis. Berzelius, the great Swedish chemist, whose determinations of the atomic weights of all the elements then known were regarded with so much admiration by all chemists, pronounced Prout's hypothesis a pure illusion. But Dumas, than whom none in France stood higher, whose opinion had great weight on account of the excellence of his many determinations of atomic weights, accepted Prout's hypothesis with a slight modification, and believed that his experiments had established its truth. Stas, the distinguished pupil of Dumas, began his work with a bias in favor of the hypothesis; but when his first series of admirable determinations of atomic weights was published, he pronounced the hypothesis a pure illusion, entirely irreconcilable with the numerical results of experiment. But Mallet, who has made several excellent determinations of atomic weights, and Clarke, who has recomputed and reduced to order all the published determinations, declared themselves forced to give Prout's hypothesis a most respectful consideration. It is obvious, then, that ten years ago it was not finally settled whether the hypothesis was or was not true.

The hypothesis, then, has disappointed our hopes of any practical advantage in conducting to a knowledge of the exact value of any atomic weight. But, nevertheless, the hypothesis has not been neglected. As was said, if it is true, we may expect from it new insight into the nature of atoms. Accordingly, an immense amount of labor has been expended in attempting to determine whether the atomic weights of certain elements are or are not divisible without remainder by the atomic weight of hydrogen. Now, since our last meeting in this city, results have been attained which show that further effort in this direction is not justified by the hope of any theoretic advantage. The chapter has come to an end. Prout's hypothesis cannot be proved by experiment.

When we attempt to decide by experiment whether Prout's hypothesis is true, the nature of the problem, and the limitations of our present knowledge and of our available manipulative skill, impose three conditions to which we must conform.

In the first place, we can more readily test the correctness of Prout's hypothesis by determinations of the smaller atomic weights. The reason is obvious. All analytical work is affected with some accidental error or uncertainty. When Herschel wrote his admirable "Discourse on the Study of Natural Philosophy," he said that it was doubtful whether we could depend on the result of a chemical analysis as having an uncertainty less than one part in four hundred. Work of much greater accuracy has been done since this statement was made; but, for the moment, let us assume that, even now, the uncertainty of a determination of an atomic weight is a four-hundredth part. This uncertainty affects a large atomic weight much more unfavorably for our purpose than it affects a small atomic weight. For instance, Stas found the atomic weight of lead to be 206·91, if we take the atomic weight of oxygen as 16. The assumed uncertainty, one four-hundredth part of this, is 0·53; so that, on our assumption, the true value is somewhere between 206·38 and 207·44. These numbers differ more than a unit; no one has a right, on this showing, to assert that the true value is the whole number, 207, nor that it is not so.

But a small atomic weight may be much less unfavorably affected by the same proportionate uncertainty. For instance, recent determinations show that the atomic weight of oxygen is 15·88, when the atomic weight of hydrogen is taken as unity. The assumed uncertainty, one four-hundredth part of this, is 0·04; so that, on our assumption, the true value is between the limits 15·84 and 15·92. These numbers differ by only one-twelfth of a unit; and both of them differ much from the nearest whole number, 16·00. It is, therefore, by determinations of small atomic weights that we may hope to decide the truth of Prout's hypothesis.

But among the smaller atomic weights, some, in the present state of our knowledge, can be more accurately determined than others. Accordingly, a second condition imposed on us by the limitations of our knowledge is, that we must determine, with what precision we can, those small atomic weights which admit of the

* Address by Edward W. Morley, the retiring president of the association.

maximum of precision. There are eight atomic weights upon which, with the experimental data now available, the decision of the matter may be fairly made to depend. These elements are lithium, carbon, nitrogen, oxygen, sodium, sulphur, chlorine and potassium: the atomic weights are, in round numbers, 7, 12, 14, 16, 23, 32, 35·50 and 39. If numerous and careful experiments show that these atomic weights are whole numbers, Prout's hypothesis has a solid basis in fact; if seven are whole numbers and the other is 35·50, then Dumas' modified statement of the hypothesis has a solid basis in fact, for 35·50 is divisible without a remainder by half the atomic weight of hydrogen.

One more condition is imposed on us by the limitations of our knowledge and manipulative skill. Our experiments determine most atomic weights, not with reference to hydrogen, but with reference to oxygen. Experiment, for instance, does not determine directly that the atomic weight of lithium is seven times that of hydrogen, but that it is seven-sixteenths that of oxygen. If the atomic weight of oxygen is uncertain, the atomic weights of the other seven elements with reference to hydrogen are all uncertain in the same proportion, although with reference to oxygen they are now determined with very small uncertainty. Accordingly, the third condition imposed on us in attempting to learn the truth about Prout's hypothesis is, that the atomic weight of oxygen must be well determined.

It may be remarked that it would be a great gain, as all chemists will see, if several other atomic weights could be determined by direct comparison with hydrogen, provided the precision attainable was of the degree which I have called admirable, or even excellent. Now, methods have been devised by which the atomic weights of lithium, sodium and potassium, as well as of several other metals, could be referred directly to hydrogen, by experiments which present no great difficulty, and which are capable of the required precision. Further, a method has been devised by which the atomic weight of chlorine can be determined with direct reference to hydrogen, by experiments capable of the required degree of precision, but involving considerable difficulty in manipulation. But until some such methods shall have been employed by some one, we must be content with the inferences which can be drawn from data of the kind now available, which depend on our knowledge of the atomic weight of oxygen as the corner stone of the system.

Our knowledge of the atomic weight of oxygen, ten years ago, depended largely on the experiments of Dumas. His results differed from the whole number 16·00 by one four-hundredth part; he himself judged that the uncertainty remaining might be one two-hundredth part. If we accept this estimate of uncertainty, we may say that he proved that the atomic weight of oxygen is included between the limits 15·88 and 16·04. No one could assert that the true number is, or that it is not, the whole number 16·00. A proportionate uncertainty, therefore, existed in the other seven atomic weights just mentioned. Accordingly, ten years ago we could not well discuss the question whether these atomic weights were divisible, without remainder, by the atomic weight of hydrogen.

The atomic weight of oxygen is, accordingly, doubly important for our purpose. The atomic weight is a small one, well adapted to aid in the solution; and, further, many other atomic weights, also well adapted to aid in the solution, depend on a prior knowledge of this constant. It is for this twofold reason that the work done since our last meeting at Buffalo is important and interesting. The members of this association have not failed to take upon themselves a fair proportion of the considerable labor involved.

Since that time not less than ten or eleven independent determinations of the atomic weight of oxygen have been successfully concluded.

Cooke and Richards were the first to complete and publish their result; they used a new and ingenious process. Keiser was next; he employed a method for weighing hydrogen which he had independently invented (though it had been previously invented elsewhere), which is the best yet used. In both these series of experiments the hydrogen was combined with oxygen by manipulation something like that of Dumas; but the improvement which permitted the direct weighing of the hydrogen made the essence of the process novel. Then Noyes devised a new method of weighing hydrogen directly, and a new manipulation for combining it with oxygen, and carried out the process in an apparatus having the advantage of great simplicity. Further, since our last meeting the Smithsonian Institution has published a work containing three series of determinations of the value in question.

In England, Lord Rayleigh used another novel method of combining oxygen and hydrogen, in which he weighed both elements in the form of gas. He also made two series of determinations of the ratio of the densities of the gases. Scott determined the ratio of the volumes of the gases which combine in several series of experiments of great accuracy. Dittmar and Henderson rendered an important service by repeating, with many modifications, the experiments of Dumas; with the advantage which the later experimenter commonly has over the earlier, they were able to secure a much higher degree of precision and to eliminate the sources of constant error which Dumas detected too late.

In France, Leduc repeated the experiments of Dumas, and also determined the ratio of the densities of the two gases.

In Denmark, Thomsen has applied a different process, in which the atomic weight of a given metal is compared with those of oxygen and of hydrogen successively.

(To be continued.)

THE NICKEL PLATING OF WOOD.

THE articles to be nickel plated must first of all be coated with metal; for this purpose the following three solutions are employed: I—1½ grammes of caoutchouc slicings are dissolved in 10 grammes of carbon bisulphide, and 4 grammes of melted wax are poured into the solution. A mixture which has been prepared beforehand, consisting of 5 grammes of phosphorus in 60 grammes carbon bisulphide, with 5 grammes turpentine and 4 grammes of powdered asphalt, is then added, and the whole shaken. II—2 grammes of silver nitrate are dissolved in 600 grammes of water. III—10 grammes of chloride of gold are dissolved in 600 grammes of water. The conducting wires are attached to the article, which, after being immersed in the first solution, is allowed to dry. The second solution is poured over it, and it is kept suspended until the surface has a dark luster, when it is rinsed with water and treated in a similar manner with the third solution. The surface has now a yellowish sheen, and the wood is sufficiently prepared for electrolytic deposition.

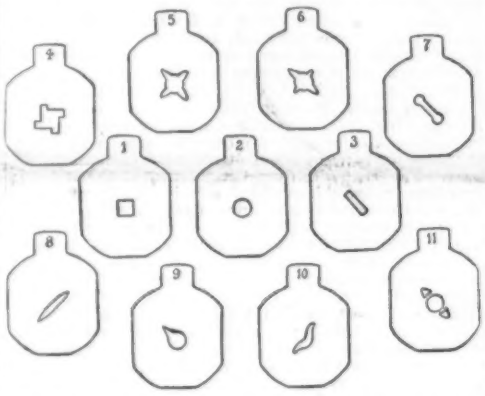
Langbein's dry process consists in quickly pouring over the article a collodion solution of potassium iodide diluted with an equal volume of ethyl alcohol; when the layer is just about to set the wood is laid in a weak solution of silver nitrate, light being excluded. As soon as a yellow color appears the wood is rinsed, exposed to sunlight and covered with copper, prior to being nickel plated.

Wooden handles for surgical instruments may be treated by immersion in an ethereal solution of paraffin or wax, and when the ether has evaporated fine graphite is powdered over them, or the wax is covered with bronze powder and all unevenness of surface removed. When the articles are to be electrolytically coated with copper they are placed in a bath, the composition of which varies with the current employed; it generally consists of 30 liters of 18 per cent. copper sulphate solution and 1½ liters of 66 per cent. sulphuric acid. When a sufficient amount of copper is deposited the articles are ground, polished and nickel plated in a bath composed of 500 grammes of ammonium nickelous sulphate, 50 grammes of ammonium sulphate and 10 liters distilled water. If blue litmus paper be quickly reddened by this solution, the acidity is reduced to such a point by addition of ammonium chloride that the reddening is only slowly developed.—Electricity.

TO AVOID "SCREENY EFFECT" IN HALF TONE WORK.

By STEPHEN H. HORGAN, Editor of Process Work in Anthony's Photographic Bulletin.

BARON VON EGLOFSTKIN saw, in 1865, the necessity for avoiding the monotonous cross lined screen effect. He overcame it beautifully by engraving with a wavy or undulating line. Artist engravers on wood, or artists skilled in the technique of pen and ink drawing, will never use parallel lines or dots with any uniformity in the engraving or drawing of shadows. The greatest objection made to the use of half tone was based on what was termed the "screeny" effect. That was due



to the half tone screen, or grating, showing too plainly in the finished engraving. This objection, it must be admitted, prevails to-day, most often when the screen used is 120 lines to the inch, or coarser. We overcome this difficulty in the United States through the use of screens from 150 to 200 lines to the inch. Lines of this degree of fineness are not readily seen, and are therefore not objectionable. There is the great drawback, however, to engravings made through very fine screens, that they cannot always be electrotyped successfully, and further, a superior quality of enameled or coated paper is required, together with the finest grade of ink to print from such plates.

There appears to be a serious obstacle to prevent the successful ruling of a half tone grating with undulating lines. Herewith are shown designs for lens diaphragms capable of rendering most wonderful effects if properly used with the ordinary half tone screen or grating. Space will not allow a detailed description of all the combinations and the resulting textures that will be obtained. The reader is supposed to know already the value of using two diaphragms during a single exposure of a half tone negative. He is also aware of the fact that each opaque dot in the negative is an image of the lens diaphragm aperture, and further, that a small aperture and long exposure must be given to obtain these opaque dots in the deep shadows of the negative, while a large aperture and shorter exposure causes these opaque spots in the high lights to blend together until only small transparent dots are left in the high lights of the negative. When the theory of half tone exposures is understood, then the value of these peculiarly shaped diaphragms will be appreciated. They can be readily cut out of what is called pressboard, though I cut mine from ferrotype plate, using three shapes of files to fashion the curves. Nos. 1 and 2 are the best to use for the small dot and long exposure. Nos. 3 and 8 will give a single line screen effect, No. 8 being the better form. Nos. 4, 5 and 6 should cut with large apertures for the short exposure, to close up the high lights. Nos. 7, 9, 10 and 11, can be made in two sizes, and by combination give a pleasing variety of textures to the half tone. It must be remembered that diaphragms, Nos. 3, 5, 6, 7, 8, 9, 10 and 11, of oblique designs, can be reversed when used in combination. For instance: if No. 9 was used for the long exposure, No. 7 would have to be reversed to be used with it, and the aperture of the latter should be much larger in proportion. It is recommended that two sizes of all these designs be made, one with double the light admitting capacity of the other, and a little experimenting will determine which combinations are most available for the work at hand. No. 10, it will be found, gives an undulating line, and renders good results with No. 9, if the latter is used for the small stop. These few suggestions will, it is hoped, point the way to more pleasing patterns in half tone work than can be had with the ordinary diaphragm and the cross line screen.—The Process Year Book.

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